





*A CYCLE OF
NATURE STUDY*

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A CYCLE OF NATURE STUDY

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PREFATORY NOTE

THESE chapters are intended to offer to Teachers, in a form more readable than is presented by the ordinary text-book or "notes of lessons," suggestions which may help them to bring their pupils into some sort of sympathetic acquaintance with their natural environment.

The objects, or rather groups of objects, chosen are such as may readily be seen in the country, or which are fairly accessible to children in towns or suburbs. The pupils contemplated are those between the lowest kindergarten age, on the one hand, and the earliest age at which it is profitable to begin definite courses of work in science on the other. No attempt, therefore, has been made to present the facts of zoology, botany, &c., in a systematic form. For the most part the method assumed is that of observation; but it is expected that the Teacher will wish to help the child to transcend its experience by the use of the imaginative powers, though not to give information which can only be a dead lift on the memory.

One of the most weighty reasons for including Nature Study in a school course is the abundant opportunity it gives for *indirect* culture; therefore, in addition to the four introductory chapters on method, suggestions for

dealing with æsthetic or ethical points, and hints for arousing in children an interest which shall penetrate other regions of knowledge and experience, have been interspersed throughout the book.

The thanks of the writer are due to Miss Hetty Lee, M.A., to various members of the staff of the Home and Colonial Training College, and to Mr. R. Holland, of the National Society, Westminster, for much valuable criticism and help.

It should be added that the following chapters were first issued in the *School Guardian*, and that most of the drawings were executed by Miss Helen Phillips. These illustrations are not intended for blackboard reproduction, but rather to guide the observation of young town-bred teachers who may use the book.

For the large and increasing bibliography of Nature Study Teachers are recommended to procure the leaflets issued from time to time by the School Nature Study Union.

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A CYCLE OF NATURE STUDY

CHAPTER I

NATURE STUDY AND THE "OBJECT LESSON"

It is not too much to say that Nature study should enter into the plan of every modern school. It is a subject which is specially fascinating to children, for it satisfies that primitive human instinct which causes the attention to be always arrested by things that live and move and change rather than by things stationary and invariable. It cultivates those powers

**Value of
Nature
study.**

of perception which are, as it were, the indispensable rootlets for nourishing the whole organism of the child's mental life, both now and in the future. It cultivates them in the direction of the *practical* interests of the child; for the things of Nature affect his daily life, and, as has been well pointed out by the American writer on Nature study, Dr. Hodge, of Clark University, man's biological relations—his domestication of animals and his cultivation of plants—have determined his

upward movement from savagery, and far more remains to be done by man in the future towards the fulfilment of the command, "Subdue the earth." Nature study appeals also to what Herbart calls the *speculative* interest—the desire to know the *causes* of things, for Nature is ever presenting new problems and new challenges to the eager spirit that is not stultified by mechanical methods of education. Here, also, the *æsthetic* interest is engaged. It is not only that Nature makes such infinitely varied appeals to the senses, in form and colour, scent and sound, but the exquisite fitting of these to the functions and purposes of the creatures themselves gives a sense of delight which fuller knowledge only serves to deepen. By the training and refining of these perceptions, Nature study opens up for the child many avenues of pure and abiding pleasure both now and in the future. The things of Nature will be to him not so many collections of alien matter, but familiar acquaintances of whose ways he knows something, it is true, but not enough to produce satiety. The world of art and of literature will constantly receive fresh interpretations, and his own artistic bent, if he have any, will be nourished from the best source.

The *moral* value of Nature study is none the less great in that it is largely *indirect*. Froebel speaks of the "quiet, impersonal teachings of Nature." He thought of Nature, indeed, as an outward reflex of the mysterious inner phenomena of the human spirit; and if this were a mystic's delusion, it is a delusion shared not only with Wordsworth and with Keble, but with many of the greatest poets and moralists and teachers of religion that have helped humanity. We cannot doubt, however, that intercourse with Nature, when thoughtfully guided, tends to deepen a child's sense of responsibility, to preserve his delicacy of feeling, and

to strengthen that sympathy with lowlier creatures which is one of the notes of a fine nature.

The object lesson.—Teachers may perhaps point out that Nature study is not a new subject, since for many years object lessons on plants and animals, and sometimes definite courses of instruction in natural history, have been provided. There is no doubt that good work has been done here and there by enthusiasts, but no one will contend that the mission of those who originated the Nature study movement was superfluous with regard to the majority of schools. Perhaps we shall best clear the ground by first examining the principal defects of the "object lesson," and then by considering the new types of lesson that are being recommended to us.

Its history.—The object lesson as devised by Pestalozzi was an exercise in sense impression and in language. Instead of learning facts from books, and committing the language of the book to memory, the children were to acquire facts by looking at the objects themselves, and they were then guided by the teacher to express their observations in suitable language. So far this was good; it was a step in a much needed reform. But from the nature of the case it was easy for the object lesson to degenerate, as we know that it did, even in Pestalozzi's own schools. The children sitting in desks,

Its defects. or on an old-fashioned gallery, at some distance from the object, which was in the possession of the teacher, could with the best will in the world make only a very unsatisfactory examination, and usually by means of no more

Imperfect sense-impression. than one sense, that of sight. The device of allowing one child at a time to come out and make as it were a vicarious examination and report for the rest had very little value. On account of the large numbers in elementary

Schools it was rarely found practicable to let each child have a specimen for itself, though sometimes a small pannikin containing a little rice or sugar would be allotted to every couple of children. Far more often the "object" itself was missing—as was inevitable when the subject happened to be the giraffe or the bamboo tree—and a picture was substituted. Pictures have their use, but a flat representation is not a good substitute for a real thing, especially with young children whose actual memory is ill-developed, and who cannot interpret effects of light and shade, colour-tone, &c. And sometimes inspectors have witnessed to being called upon to listen to object lessons given to children when not even a picture was provided! The *language* training of these lessons often resolved itself into the

Language training artificial. addition to the child's vocabulary of words that he would never be required to use in his daily life. Teachers, as Sir Joshua Fitch remarked, would solemnly record upon the blackboard that a cow is gramini-vorous or that an orange is opaque.

Even in favourable cases there was a certain poverty and lifelessness about the observation of plants and

Want of "living-ness." animals, arising from the fact that these were treated as "objects" and not as living things, with their own favourite homes and modes of activity. The

"livingness" of the creature could hardly be realised when it was presented in a hurried, fugitive way, sundered from its proper habitat, and with no presentation of the conditions and relationships on which its existence depended. What could not be seen in the class-room and within the limits of the one lesson would probably be given as information by the teacher. This information would be arranged under headings such as Structure, Parts, Qualities, Uses, &c., and written on the

blackboard. The teacher very often gained his information from a handbook which not only supplied him with the facts, but also carefully instructed him as to the "method" by which he was to present these facts to the children's minds. Since no spontaneous action on the part of the children was contemplated, the illustrations and questions and other devices prescribed in the notes could be used almost mechanically, and the teacher was thus positively hindered from finding out what was the real attitude of the child's mind during his disquisition. There is no doubt that these lessons, if given in a sprightly manner, at any rate afforded a welcome change from the monotony of the "three R's"; but the fact remains that the child was mainly receptive, and not active, throughout the teaching. And, the

**Want of
provision
for applica-
tion.**

lesson over, he had no opportunity of applying or expressing what he had learnt, except by piecemeal questioning at the recapitulatory stage. No little problems or investigations were set him in preparation for the next lesson, which, indeed, would probably be on a wholly disconnected subject, not revealed until the teacher disclosed it in the "introduction." A lesson on "rice" would be followed by a lesson on "coal," or on "a camel." And,

**Want of
connection.**

finally, the mention of the camel reminds us that these subjects, besides being disconnected, were often so entirely remote from the child's environment as to have little or no value in training him to use that environment as a means of self-education, though they would of course have their place in connection with the descriptive geography of other lands. These are the chief indictments against the ordinary object lesson; it remains to be shown whether the methods of Nature study can be made more fruitful for the benefit of the child.

CHAPTER II

THE DISCOVERY LESSON

FOR the object lesson we have now substituted some form of "observation lesson." The change of name is significant; it shows that the concern of the teacher is not so much with the actual material of the lesson as with the process going on in the child's mind. The "Suggestions" of the Board of Education have given currency to the title, but we think that these suggestions are mistaken in assuming that all observations are of equal value, and still more in relegating everything that is *not* observation to the "reading lesson, the oral composition or conversation lesson." This is very artificial, and ignores the free play of the child's mind upon the subject of the lesson. The term "Discovery" or "Investigation" lesson may be preferable as giving more freedom to the teacher.

First type of discovery lesson.—There are two types of discovery lesson. The first kind deals with objects or natural conditions outside the schoolroom. These will, of course, vary according to the environment. The town child will naturally observe buildings, officials, vehicles, shops, &c., and these must not be neglected in his school life. But such a child should also be asked to observe the trees and shrubs and flowers in the parks or gardens, the commonest domestic animals, and the pigeons, starlings, and sparrows that haunt the streets or open spaces. The slenderer gifts of Nature that have endowed his home must be utilised to the full, and as we shall see

in a subsequent chapter, the teacher can do much to supplement these scanty opportunities. The country child will of course have a far wider range of natural objects to observe, and he must be encouraged to observe them with sympathy and interest.

The method of such a lesson would be to invite the children to make observations on some one object or group of associated objects for a certain period, say a week, and at the end of the week the "lesson" would consist in gathering up these contributions from the class, correcting any wrong impressions, inviting suggestions as to the possible "why and wherefore" of any peculiarities they have observed, and pointing out the lines of future observation. This kind of lesson secures that the training of the eyes and other senses shall go on out of school as well as within, and this is of itself a great benefit to the child.

Second type of discovery lesson.—But since the memory images of the young fade quickly, a second type of lesson is necessary, in which the actual object or group of objects is *present* for reference, comparison, or verification. In a future chapter we shall discuss some contrivances by which this may be secured both in and out of doors. Both these types of lessons are essential in Nature study.

But the teacher must not suppose it possible to teach from Nature successfully if he is still bound by the tradition of the hand-book of lessons which arranges that a topic shall be begun, discussed, finished, and formulated in one brief weekly or bi-weekly lesson. His observations on so common an object as a carrot, for example, would run into a second year. Nature is not a conglomeration of detached objects which always present the same appearance and therefore can be examined at any time and dismissed with a

sense of knowledge. She presents us with a great and endless series of *time-changes* constantly going on before our eyes; and of the humblest weed as of the weathered hill-crest it may be said, "Nothing continueth in one stay."

Discovery must be continuous. If we would know anything of her operations, our study must be *continuous*. Instead of the old stock lessons on "Parts of a Plant," where the organs and their uses were exhibited and tabulated at once, the children should be helped to follow the whole life history of a plant, from germinating seed to matured fruit, and from one generation to another. Ruskin said long ago: "What we specially need at present for educational purposes is to know not the anatomy of plants, but their biography. We want them drawn from their youth to their age, from bud to fruit." *

It is the same with animals. How can the children come to know the life and habits of a creature whom it sees under artificial conditions which prevent its behaviour from being normal, and for a brief half-hour only? Obviously, only a fraction of the characteristic ways of the creature can be observed in that time. So that the teacher must not aim at "finishing" a lesson in the sense of exhausting a topic. If the observations are to be continuous, spreading over a considerable period of time, his work in making use of them must also be continuous. He must not be disturbed if his note-book does not show sets of concise statements arranged under headings as "summaries" of lessons taken on such-and-such dates. (It *may* and *should* show dated records of the examinations made, or the spots visited in company with the class.) The traditions which approved and required such methods are now fast disappearing, and in schools of any grade working under the Board of Education a teacher

* Lectures on Art.

would find no difficulty in obtaining sanction for the "continuous" method from inspectors and other officials concerned in his work.

Again, Nature is not merely a series of time-changes, but a mighty, beneficent complication, whereby her forces and her creatures are bound together in the meshes of mutual dependence. The teacher will

Connected- be aware, for instance, of the unceasing
ness. Study ministry of the plants in purifying the
of creatures air for animal respiration, and how the
in groups. air and soil are enriched from the plant by

the waste products of the life processes of the animal world. Before the child is ready for these conceptions he can be prepared for them and for other generalisations by noticing not only the appearance of a plant or animal, but also where it lives, what soil, aspect, or climate it likes, what things live with it or near it, what enemies and friends it has, and where and how it gets its food. Hence a group of objects must be under review at the same time, the different phenomena of Nature must be, as it were, pieced together. The principle of *connectedness* no less than of continuity, is of the highest importance.

Finally, in all true Nature study it is the child who must do the work. The principle of *self-activity*,

Self- the watchword of all reform in modern
activity education, must never be lost sight of.

must be The children must make their own observa-
involved in tions and their own records. The business
observa- of the teacher consists in contriving favour-
tion. able conditions under which Nature and

the child may be in contact, and in sharing with the child in the scrutiny of what Nature reveals. For the hand-book of prepared lessons the teacher must substitute the method which he himself enjoins on the child—"Watch!"

This is not to say that the child must never be told anything which he cannot test by eyesight or other senses. There is a pedantry about the so-called "heuristic" method by individual discovery, which is as mischievous as that which hung about the old methods of "imparting" knowledge by sheer lecturing. If a child

wants to know where the swallows go in winter, he must be told. He cannot be transported to Africa to find out. It is the business of the teacher to nourish imagination no less than to train the observing powers.

The point to remember in this matter is that the new information should either satisfy some natural curiosity or it should help imagination to transcend experience. We must *supplement* experience, and not strive to *replace* experience by offering unrelated instruction, as we sometimes do, for instance, by abruptly giving an unconnected lesson on Migration. We should not supply what Professor Geddes calls "pickled facts." The better way is to interest the child so that he is prompted to ask questions, and then, unless he can answer them for himself by further watching, to provide him with material for mental images the construction of which will give him real intellectual pleasure.

It is apparent from what we have already said that Nature study must not be confused with botany, zoology, or any other science dealing with natural phenomena. In the words of Mr. Hedger Wallace (University College School, London), "Science teaching, even when elementary, is a form of specialisation, and this should be deferred until late in school life. What

Nature study is not science.

Nature study desires to further is that close intimacy with Nature, that vividness of outlook, which is the foundation of the craft or lore of the shepherd and the gamekeeper, the farmer and the gardener, the sports-

man, and scout, the fancier and naturalist. . . . The teacher is not teaching science: he observes things on the surface, and does not delve at all, but he is accurate as far as he goes." At a later stage, certainly not before the age of twelve or thirteen, the child can begin botany, let us say, as it is ordinarily taken in schools, with experiments involving ideas of chemical changes, with dissections, and with microscope. Until that time comes, he may well be content with the thoroughness that consists in seeing something accurately with his own eyes, and with the accumulation of a store of images in relation thereto.

CHAPTER III

THE WAYS AND MEANS OF NATURE STUDY (I)

As we have already suggested, the set lesson is by no means the only, or even the chief, vehicle for giving the children a knowledge of the ways of Nature. Other and varied arrangements must be made, and if the teacher regard these as troublesome, he will nevertheless be amply repaid by the zest with which the children will enjoy the results. He will find, too, that their interest in this one subject will so quicken their minds as to bring about an appreciable improvement in the earnestness with which they set about other school tasks.

Outdoor observations.—Outdoor observations can be made, as already indicated, by the children themselves. But in giving directions or suggestions for these the teacher is at once embarrassed by the immense choice *offered to him and to them*. It is of no use to "give a vague injunction to go forth and observe Nature. It is true, as Emerson says, that "the best part of a boy's schooling is that which he gets on his way to and from school," when he simply looks at what he cares for. But, in dealing with numbers, some definite line of observation must be laid down, and what is lost in spontaneity is made up for in friendly rivalry and in the sympathy that comes of the same pursuit.

In other words, the teacher must have in his mind some sort of scheme. Thus for one year he might ask his class to observe common English trees, or even

one or two of such trees. This in itself would necessarily involve the inclusion of a large number of associated topics, for besides the study of the Schemes. bark, branches, twigs, buds, leaves, flowers, fruit, &c., no survey would be complete which did not include a study of the insects, birds, and other living creatures who frequent the tree or make their homes in it. If it be considered that the common oak forms the habitat of about seventy species of insects, it will be seen that there would be no lack of material in dealing with this one tree only. Or the observations might be seasonal in character, aiming at an acquaintance with more phenomena, but in a more superficial manner. The choice of a scheme would depend also very largely on the position of the school. A very suggestive five years' course has been worked out by Miss C. von Wyss, honorary secretary of the School Nature Study Union.* A suitable course for any one year might easily be selected from this scheme, and during the year the teacher would be sure to discover what particular lines of work would be likely to afford most interest and profit to his own scholars in the ensuing years. In the following pages such objects or groups of objects will be selected for study as would seem likely to attract scholars who had been hitherto untrained in this kind of work. No attempt will be made to treat the topics exhaustively. *Directions* of work only will be suggested, and the opportunities of the teacher and the interests of the scholars will indicate the lines on which *special* study may be carried on. The watchwords of the teacher in Nature study are, as has been well said, "Season, Situation, and Opportunity."

The outdoor lesson is given in the presence of the natural objects as they grow or live in their proper

* This may be obtained from Mr. H. E. Tugner, Bellenden Road School, Peckham, S.E. Price 2½d. including postage.

habitat. The children will gather round the tree, for example, with their note-books, and watch at the different points suggested by the teacher.

The field lesson. It is an excellent plan to mark a twig with a piece of coloured thread or tape near its insertion at the branch, and let the children measure from time to time its growth from the tape to tip. The twig may be labelled with the date, and with the name or number of the scholar who first observed it, so that he can make it his special study. The insect and the bird life of the tree can also be best studied in these outdoor lessons.

It may be that the *locus* of the lesson is the edge of a pond, or ornamental water in a park, a hedgerow, a little copse, a meadow, a bit of common, or the border beds in a public garden. Here the teacher will find it best to ask different children to look for different things. There will then be a free time in which the class disperses for the purpose, and with good discipline this freedom will be quite possible, as it is certainly desirable. (We have seen outdoor lessons in which the whole anxiety of the teacher seemed to be to keep the children "in life" while he or she addressed them!) The class will return to the teacher and report. Finally

Reports and records. the teacher, having gathered the little troop together, will lead them to examine

the various objects in turn, verifying, and if necessary correcting, the observations made by the reporters. This, by-the-by, affords excellent language training; and, without exacting too much homage to the fetish of the "complete answer" or the "complete sentence," the children can be encouraged to give a clear account of what they have seen and of what they think about it. The teacher will find that he need question less and less, and by substituting for the usual catechetical style of teaching

the recitation method used so much in America, in which the children learn to stand and deliver their own statements without hesitation or *mauvaise honte*, he will be doing his class a great service. Besides reporting in clear speech on the spot, written records will, with appropriate drawing, be afterwards made either at home or at school in the pupils' note-books. It is needless to remark that in order to get the best results from a field lesson a preliminary survey of the ground should be made by the teacher.

Field lessons in town schools.—Field lessons in town schools are of course difficult to arrange, but not all is yet done that is possible in the way of meeting the difficulty. The public parks and gardens, which are becoming more and more intelligently planned (though far too few provide labels giving the English names of the trees, shrubs, &c.), might be made much more useful for school lessons of all kinds. More might be done by teachers and managers in the organisation of visits to such places as the Zoo, Hampstead Heath, Epping Forest, and Kew in the cases of London children, and to analogous places in other large towns, while local authorities might facilitate means of transit. And the Sunday school, which is crowded day in the year, might have a few quiet rambles of one or two hours. A scheme for mutual aid between town and country schools (Hon. Sec. the Hon. Cordelia Leigh) has been in operation since a fortnight a collection is sent once a week of plants from the illustrated and of natural objects from the town school must have a return interesting cutting lessons, and such a scheme, other papers. Obviously local authorities in providing larger proportion of indoor schools, should do much auxiliary to the action of the "Botany Boxes" for the

to render pleasant indoor lessons possible to children who can take fewer school excursions.

In order to train in exactness of observation and to lay the foundation for the scientific habit later on, the

Records of observations. results of all the more important observations must be recorded. All but the youngest children can have a note-book in which to enter a dated record of what

they have seen. As the children gain in experience the note-books will be of two kinds: (1) A diary or statistical note-book, as it may be called—a calendar in which the pupil notes such matters as the first appearance of flowers or birds, weather observations, &c.; (2) a descriptive and pictorial note-book, also dated, in which he describes in his own words, without reference to books, what he has observed of an animal or a plant, with illustrations drawn by himself. Sometimes a drawing will suffice for the complete record, formal statements in words being dispensed with altogether. The drawings may be rough; the child need not aim at *finish* while he is recording an impression, but he should try to make the representation as truthful as possible. The sketches should be his own, taken from the object itself. The practice of drawing the object on the black-board, and leaving it there for the class to copy, tends to produce "neat" work, but from the point of view of Nature study it is no less an authority than Professor Miall points out as "extremely mischievous." It is no less the by-product of the art point of view.

Help given by pictures, &c. It is also true, as Brownie remarks, that

We're made so that we love

First when we see them painted, things we have passed

Perhaps a hundred times nor cared to see.

A picture is not a substitute for Nature, but it helps

to illuminate Nature. If the teacher can show his class a copy of Landseer's "Squirrels," or McWhirter's "Lady of the Woods" (the silver birch), he will help them to see and to admire, and this is a long way on towards loving. Moreover, children are such generous critics that they will admire and love the thing drawn before them by the teacher. Let the teacher therefore draw before the class (no extraordinary powers are needed for this) the objects they are studying together, or details thereof. This will sharpen the perceptions of the slower children. It may even be good on occasion to prepare what may be called pre-perceptions in the minds of the class by hectographing copies of *small* objects which are to be observed; the copies to be, of course, on a larger scale. This will rouse the expectant form of attention, and guide the observation of the thing itself. These hectographed drawings should be pasted in a separate book, and not among the "records." Neither the teacher's drawing nor the hectographed sheets should be used as "drawing copies."

The use of water-colour sketches should be encouraged from an early stage. Nature study begins in the infants' school, and we may point out that little children naturally work much better with chalk or with a brush than with pencil, since the use of the latter involves more strain on the delicate muscles of the fingers and on the nerves governing their movements. After a Nature study talk the little ones should paint lines and specimens on sheets of paper fastened to mill-boards. By the time they are promoted to books they will be accustomed to a free mode of representation, and if their perceptive powers have not been spoiled by too much mechanical copying or by "blobbing," they will make records which are interesting to themselves and which will help to establish a permanent habit affording delightful recreation in the future.

CHAPTER IV

WAYS AND MEANS OF NATURE STUDY (2)

The school garden.—The school garden is a means of supplementing outdoor investigations and fixed lessons, which, though specially valuable in town schools, where gardens have been managed very successfully in many cases, is yet very useful even in the country for giving interest to the home garden, as well as to the walk to school or the holiday ramble. Teachers who have successfully managed school gardens suggest that the various beds should be allotted to different descriptions of plants—bulbs, underground stem plants, tap-root plants, creeping stems, prickly plants, climbing plants, &c. Plots 6 feet by $4\frac{1}{2}$ feet, separated by paths, will be found of a convenient size, and the climbing plants can, of course, be grown against a wall or trellis.

Devices for observing plants in school.—The school garden may be provided with any number of small annexes within doors or on the window-sills. Seedlings may be raised on damp flannel or blotting-paper, on slabs of bath-brick kept moist, in sawdust or cocoanut fibre, in moss within a lamp-glass, as well as in soil. A plant may spend its whole existence in the class-room until blossom-time, and then be placed on the window-sill to be fertilised by bees or other insect visitors. The persistent care of these plants is a valuable education to the children. A table may be allotted to jars of water containing twigs with developing buds. Another may be furnished

with specimens of the wild flowers in blossom at the time with their (common) names attached.

Animal pets. The aquarium and terrarium.—Provision will be made in some schools for animal pets, such as rabbits, pigeons, &c., though it is often possible to get children who own such creatures to lend them for a sufficiently long period. The care and responsibility of these should not fall on the caretaker of the school, but on the steadiest of the elder pupils, the eye of the teacher being directed towards their operations from time to time. Observation of water creatures in their natural home is difficult, and yet they are very interesting, so that an aquarium should be provided, or, rather, several smaller aquaria. This is a better arrangement both on account of the weight and also because the more voracious creatures, such as sticklebacks and water beetles, cannot be put with others. Tadpoles, goldfish, water snails, &c., can be easily observed in small aquaria, the tadpoles being, of course, transported elsewhere as soon as they are ready for terrestrial travels. A terrarium—a device for studying *terrestrial* life—can be made of a box with gauze or perforated zinc covers and glass substituted for wood in at least two of the sides. In boxes such as this larvæ and pupæ may be placed and their development watched. We shall discuss the necessary arrangements further during our study of the occupants, but it is well for the teacher at the beginning of the year to be getting together the apparatus he will require, and managing it as inexpensively as possible. For work of this kind, as well as for making labels and tool-boxes for the garden, the productions of the woodwork class should be utilised wherever possible.

Museums and collections.—A school museum is generally a very dreary affair, consisting of a dusty assortment of "curiosities." These are of little value

educationally, as the objects are accumulated haphazard, without relation to any definite purpose. Even collections of fossils and shells, birds' eggs, and the like, amassed with some regard to system, are disappointing; they lack living interest to young people who have not grasped the principles of their classification. But though the classifying faculty comes later, the collecting instinct is strong in pupils under twelve, and should be made use of. Collections of twigs, leaves, flowers, fruits may well be made and displayed from time to time. It should be remembered that the value of such collections, though great to the collector, is very little to the beholders unless they are the class-mates and friendly rivals of the donor, and it is therefore desirable that these hoards should, as a rule, be only temporary in character, and should be replaced by fresh sets as the passing years bring fresh scholars to the class.

Another point to remember with regard to the ordinary cupboard with glass doors which serves as a school museum is that the continual contemplation of the same objects blunts sensibility. It is better to have a blind over the glass door, and to bring out the objects *one at a time*, in order that each may have all the interest that attaches to freshness. Thus a stuffed bird may be exposed for a week, during which the children can look at it, tell their parents about it, and find out all they can in preparation for anything the teacher may have to tell them before it is replaced.

Experiments in Nature study.—For children under twelve, to whom Nature is a fascinating tangle of movement, colour, and form, observation is the method on which we must chiefly rely. Experiments must play a certain part, but we have to remember that we are not teaching science, and, further, that we have to teach respect for the "livingness" of the objects of

study. The experiments used must be very simple, and must not involve a knowledge of chemistry or physics to interpret them. Even the iodine test for starch is apt to seem a bit of jugglery to children who have not grasped the idea of chemical action. Our experiments should rather resemble the haphazard experiments which Nature sometimes performs for us—*e.g.* growing plants in the dark. The analogies of child life and the life of the lower organisms will often serve as a satisfactory though partial explanation of facts, which will receive fuller elucidation in the botany or biology class later on.

Nomenclature.—The same spirit of compromise between the purely observational and the systematic and scientific study of phenomena will guide us in the use of words. It would be pedantic, for example, to give a child under twelve the word "parenchyma," but the word "stigma" will be useful at a quite early stage to fix his apprehension of an object he frequently notices. The word is needed to clothe the idea, and to find out this need the teacher, while studying Nature, must not forget at the same time to study the child.

Correlation with art subjects.—The question of drawing, discussed in our last chapter, suggests the correlation of Nature study with other subjects. Obviously the art teaching of the school in drawing, painting, designing, and modelling will gain very much in vitality and interest if the subjects are drawn from the Nature study course. Moreover, the exercises of the art lesson will make the pupils more and more sensitive to the beauty of form as such which natural objects display, and to that exquisite fitness of form to function which is a perpetual revelation to the Nature student. To enlarge on the ways and means of assisting this process would be to make an excursion into the subject of method in art teaching. It must therefore suffice to

point out that serious waste occurs if the teachers of the two subjects do not act in some kind of partnership.

Correlation with literature.—It has been pretty fully realised by teachers that the various subjects of pure "instruction" should interpret and reinforce one another as far as possible, and "school readers" provide abundant opportunity for letting the child become acquainted with what the great artists in words have thought and felt about Nature. They provide, moreover, versions of the great myths which show us how Nature was conceived of by our simpler ancestors. The return of spring, for instance, is finely and beautifully expressed to a child, as to an ancient Greek, by the story of Persephone, and the death of Baldur is a myth of winter which may well touch the imagination of northern children. Two opposite dangers may, however, be pointed out. The first is to give the child

Caution. literary material which is too far beyond his present range of feeling. A child of eight will not appreciate either the measure or the sentiment of Herrick's "Daffodils" merely because he happens to be studying daffodils in class. There is a danger, from the point of view of Nature study, that he may enjoy the daffodils less on account of the unintelligible matter he is called upon to learn in connection with them. Worse still, he, or more probably she, may be infected by a kind of false sentimentalism about the blossoms because some such emotion is apparently expected by the teacher. The other fault, also committed under the influence of the mystic word "correlation," consists in giving the children trivial stories of plant or animal life *below* their stage of development. These stories are often saturated with a spurious human psychology, as though plants and animals, with their struggles and ingenuities and triumphs, had not interest enough of their own for us to study. Thus, we have heard a daisy described as yearning to be

carried up into the air to share the wide view of her neighbour the lark, and the complaisant lark accordingly gratifying her wish! Such stories, of no literary merit, and false in sentiment as in fact, are apt to disgust sharp little boys and girls with Nature study before they reach the age when it would be more and more of an intellectual delight to them. An earnest consideration for truth and for the good of the children, and a persistent training of the teacher's own taste by deepening familiarity both with Nature and with the best literature of Nature, will be the strongest preservative against these errors. It only remains to be said that much of the finest and noblest work in English literature is only fully intelligible to one who has gathered the "harvest of a quiet eye" in such early and long-continued companionship with Nature as we are now endeavouring to secure for the children in our schools.

Correlation with geography.—The connection of Nature study with geography is too obvious to need much insistence. In the early stages the two subjects are quite inseparable, for the child gains his first notion of the spaces around him by observing, in his explorations, what scenery they present, and what occupants they have. He gradually learns to see how both the scenery and the occupants of his particular spot of earth are affected by the action of the great forces of solar heat, air movements, and water movements. He learns to realise imaginatively how these forces affect plants, animals, and human beings in far-off regions on the same planet. He has to *think out* for himself a new country in terms of climate, flora, fauna, and, dependent on these, the occupations of the people. The old system of teaching geography, as such, by lists of names, is hardly possible to-day. And the science of physical geography has its beginnings in the field lesson, in the weather observations, in the pet-keeping and gardening interests of quite young children.

CHAPTER V

OBSERVATIONS OF THE OPEN SKY

SINCE all natural life is subject to "skiey influences," it is good to have arrangements made for observing and recording the weather. The "open sky" is a subject of study which is too often overlooked, even in towns, where its pageantry should draw our eyes to it the more because objects of natural beauty are so much fewer. Let the children therefore observe the state of the sky: later on they will trace with more keenness the connection between changes in sky and air and the organisms they study.

The sun.—Many children, though they may know that the sun rises in the east, imagine that this rising takes place at a fixed point all the year round. To correct this, let them notice the position, let us say, of the winter sun in the sky as soon as morning school opens, and suggest similar observations for the home. Let them notice the time by the clock when a ray first enters any convenient window (say one facing a southerly or south-easterly direction), and also when it leaves a south-westerly window in the afternoon. They will find that about March 20 (the vernal equinox) the sun does indeed rise due east and set due west, and it will be seen in the sky for exactly twelve hours. From this time on towards mid-summer, the sun will rise more and more to the north of east, and set more and more to the north of west,

making, as each day passes, a higher arch in the sky, and giving us longer hours of daylight. After June 21 the sun appears to "turn back"; it travels no farther towards the north, but instead begins to recede, as it were, towards the south once more. This continues until about September 22 (the autumnal equinox), when the sun again rises due east, sets due west, and gives English children days twelve hours long. It then proceeds still further south until about December 21, and at this time it makes only a very low arch in the sky and gives us short days. From December 21 to March 20, however, it climbs higher in the sky, and its points of rising and setting move towards the north, until near the spring "quarter day" we have again a rising and setting due east and due west, and a day twelve hours long. The reason of this spiral movement can be demonstrated with globe and candle in the physical geography lesson, but for the majority of children under twelve it will be sufficient to have taught them to notice these movements as they appear to the observant ploughman or shepherd, and to have excited their curiosity to the point of consulting a calendar to find out what happens during their sleeping hours.

Let the children also notice *how far* a ray travels into the room at different times in the year. They can mark the extreme point reached by the ray by fixing a drawing-pin into the floor, or painting a dot, marking also the date. They will find that the entering rays are longest in winter, when the sun is low down in the sky. As the sun mounts higher, the rays shorten; but we gain more heat from them than from the more slanting ones, and the heat increases as the rays approach more nearly towards the vertical. Let them notice the effect of sunshine on plant life. What kind of plants grow in gardens on the side facing the north, for instance?

Ways of finding direction.—These observations imply that the children know the points of the compass. While they are observing the path of the sun, **By the sun.** make a rough sundial by driving a pointed stick into the middle of some open space out of doors. Let the children repeatedly notice the shadow on bright days throughout the year, and especially the *direction* of the shadow cast at noon. This gives the north. They will notice that the *length* of the noon shadow varies at different times in the year—it will be at its shortest on June 21. Compare this with the marks on the schoolroom floor. They will see, too, that the shadow appears to travel round the stick, the morning and afternoon shadows being on opposite sides. Thus we can roughly tell the time. Let them compare with a real sundial.

Stories of squatters and of people wrecked on islands will show the help given us by the sun in determining *time* and *direction*. But what is to be done on cloudy days? Show a magnetic compass **By the compass.** and experiment with it in comparison with the north and south line of the shadow at noon (ignoring for the present the slight divergence apparent). Show its behaviour in other places and let them use it in conjunction with sun observations, for orientating rooms, and for finding their way on school excursions.

Elder children may also be asked to look out, on winter nights especially, for the more striking constellations, such as Orion with his sword and belt, Cassiopeia's chair, and the Plough or Great Bear. **By the stars.** Make hectograph drawings to help recognition, and to show them how to find the Pole Star, which never moves from its place in the north.

They have now learned three ways of finding the north. Could the stars also help us to find the time

if we were crossing a desert and had no watch? They may notice how the Plough, for example, seems to change its position between tea-time and bed-time on a winter night. Help them to imagine how sailors and shepherds of old would tell the advance of the night by watching the movement of the constellations slowly swinging round the fixed point of the North Star.

The moon.—Many grown-up people, if asked to draw the phases of the moon, would probably draw the crescents of the waxing and waning moon respectively looking the wrong way. Let the elder children, especially on winter nights, make notes of (a) the time of the first appearance of the moon in the sky, (b) its position at that time, and (c) its shape. They will notice that the "new moon," with the horns of its slender crescent turned to the *left*, appears in the west soon after sunset, and sets early. On succeeding nights, still growing towards the left, it appears farther and farther away from the setting sun, until at full moon it rises in the east opposite the setting sun. Then the moon "*wanes*," the bright portion decreasing towards the *right*, and rising later and later, so that the children may see it in the western sky in the morning as they come to school. It may be useful to note that the *growing* phase, whether light or dark, is always on the right hand as the spectator views it. In about twenty-nine days the moon has come back to its original aspect, and new moon recurs.

The harvest moon.—For several days in each month the moon rises at nearly the same time. When this happens either in daylight or after midnight and the moon is not full, we do not notice it. But for some days in September the full moon rises due east at about the same time that the sun is setting in the west. This gives us the "*harvest moon*," by whose light the reapers can work in the fields after sundown. The

children will notice how large the full moon looks when it is low down in the sky. This is because we insensibly compare it with the objects near it—trees, houses, &c. Tell them to pierce a card with a pin and look at the rising moon through the hole to find out what is now its apparent size. On summer evenings they may

Other moon observations. note how the moon decolorises their favourite flowers, making poppies appear black, yellow flowers white, &c. Do not

let so beautiful an object be vulgarised by associations with the grotesque face of "the man in the moon," otherwise they will not be able to escape from the suggestions of nose, mouth, &c., whenever they look at it. Let them hear from the first that these markings are mountains, and show photographs of them.

Tennyson speaks of the "long glories of the winter moon." During the winter the full moon rises early and sets late, and most children will have a chance of noticing also how high she rides in the sky at that time, whereas in summer she is not so long above the horizon and rides much lower down, so that we have her fullest light and splendour when we most need it. How does the moon affect the "coming in" and "going out" of the tides during the summer holiday? Let them watch, and also consult calendars to find out. Is there any truth in the old saw that a change in the moon means a change of weather? Let the children pose this question to their elders at home and enlist them in the task of keeping records extending over some months to find out whether there is any truth in the saying, or whether it is not that coincidences are remembered and negative instances forgotten.

Clouds.—"The floating clouds their state shall lend to her." Whether this be only a poet's fancy or

THE SKY

THE WIND

MONDAY		9 A.M.		4 P.M.	
TUESDAY		9 A.M.		4 P.M.	
WEDNESDAY		9 A.M.		4 P.M.	
THURSDAY		9 A.M.		4 P.M.	
FRIDAY		9 A.M.		4 P.M.	

FIG. 1.—SUGGESTIONS FOR CALENDAR OF WEATHER CHANGES

not, it will be an education to the children to watch the beauty and dignity of the form and motion which they see in cloud masses. Long before they need learn the words cumulus, cirrus, stratus, &c., they may learn to recognise the white-domed lifted masses, the light curled clouds and the long level lines, and to represent these by drawings. All children, too, should

Wind. be taught to read the direction of the wind, not only by the weathercock, but by such signs as the movement of flags, of smoke, of clouds, and by noting the way in which the trees bend and the water in the pond is rippled. Let them notice at the seaside or in exposed situations whether groups of trees are bent in one direction. The younger children may indicate the direction of the wind by adjusting a cardboard arrow or fish fastened to a knitting needle, which is stuck into the middle of a cube, the sides of the cube being named from the points of the compass and placed so as to correspond with the walls of the room, so that the teacher or monitor may see on which side the windows and ventilators should be opened.

Both the younger and the elder children should be encouraged to make calendars. The younger children can make wall calendars not only for the first appearances of flowers, butterflies, &c., but also to show weather changes, using white chalk on blue paper for clouds, grey for dull sky, yellow for sunshine, slanting lines for rain, &c. The elder children should add readings from the thermometer and barometer, and if it be urged that they do not understand these instruments, the same objection, it must be remembered, applies to the telling of time by the clock. Some such arrangement as that given in the drawing may be suggestive; it is obvious that the number of columns may be increased to show

**Construc-
tion of
calendars.**

temperature, age of the moon, &c. ; each column being entrusted to some particular child for a week.

The children will be found to take up this work with enthusiasm at the beginning, and then, being children, they will "forget" and interest will tend to flag, except in the case of a select few, for whose sakes alone, the teacher must remember, it is well worth taking trouble. But much may be done to keep up interest by allotting five minutes every day at the beginning of morning school to the "odds and ends" of Nature study, to looking at new specimens a child may have brought in, to seeing that the plants and pets have been cared for, and that the various weather observations are duly posted up. Fresh questions and suggestions of "looking out for so-and-so" can also be put at this time. As we have said before, if Nature study is to be of any use, it must be continuous, and in no subject is continuity less wearying or more likely to reap its reward in the tastes and habits that will be formed in the pupils.

CHAPTER VI

BIRD LIFE IN WINTER

THE winter, especially if it happens to be a severe winter, is a very good time in which to begin to interest children in bird life. A walk along a hedgerow, across a common, through a wood, or even in a park, will reveal the whereabouts of last year's nests, and hence an indication of future nurseries, which are not to be rifled, but to be watched. Any empty nest may be shown, and its special construction noted. The beautiful nest of the chaffinch, for example, cup-shaped, and cleverly woven together of moss, cobwebs, feathers, rootlets, and lichens, with an outside covering of ends of moss and lichen that makes it difficult to detect in the fork of a tree or the thickness of a hedge, if shown to children by a sympathetic teacher, may induce a tender, protective, and reverent feeling for the bird, and a desire to watch her ways, which is quite foreign to the barbaric instinct of robbing her of her eggs. The nest raises the question, What has become of the busy parents, and the carefully brought-up broods who tenanted the hedges and copses in spring and summer? Some of them, especially those which are dependent on insect food, have departed to warmer countries where insect life is still fairly abundant. Others, such as blackbirds, thrushes, and robins, who prefer an insect diet, can, nevertheless, make a living on vegetable diet, and therefore we find many of them

spending the winter with us. Provision has been made for these in the hips and haws, the privet berries, holly berries, ivy berries, and so on. Of these the most palatable are soon devoured, and the children can note the diminution in the supply as the winter wears on.

**Bird
migration.**

And since our country, cold as it seems to us in winter, is mild compared with Norway and other countries farther north than ours, our native birds have to share their provisions with many foreign birds that come to us for the winter—the fieldfares and redwings, for example, who haunt our fields and hedgerows in flocks. Many birds that do not actually live out of the country will move from one part to another in search of food. To London children and children who live in the shires bordering on the sea the most familiar instance of this

**Gulls in
inland
haunts.**

will be the black-headed gulls, who fly inland to the ploughed fields, or to rivers and other waters in towns, in search of food. From any of the London bridges or from the Thames Embankment they may be seen flying, wheeling, and darting in most beautiful curves to catch the pieces of fish or other food thrown to them, or resting on the edge of a deserted pier, with their heads to the wind, so that the feathers of the back may not be ruffled. The blackness on the head does not show until the spring. The children may be set to watch for it. When patches begin to show on the side of the head it is a sign that the birds will soon take flight. In the meantime they may have a hint of the pleasure it will be to them to watch the gulls as they fly, the pure white edge showing along the front of their outspread wings, and every movement full of grace. It is by no means one of the least advantages of Nature study that it trains the eye to admire form and beautiful movement as such, and this training will

do more than appears at first sight to remedy faults of roughness and clumsiness in young people.

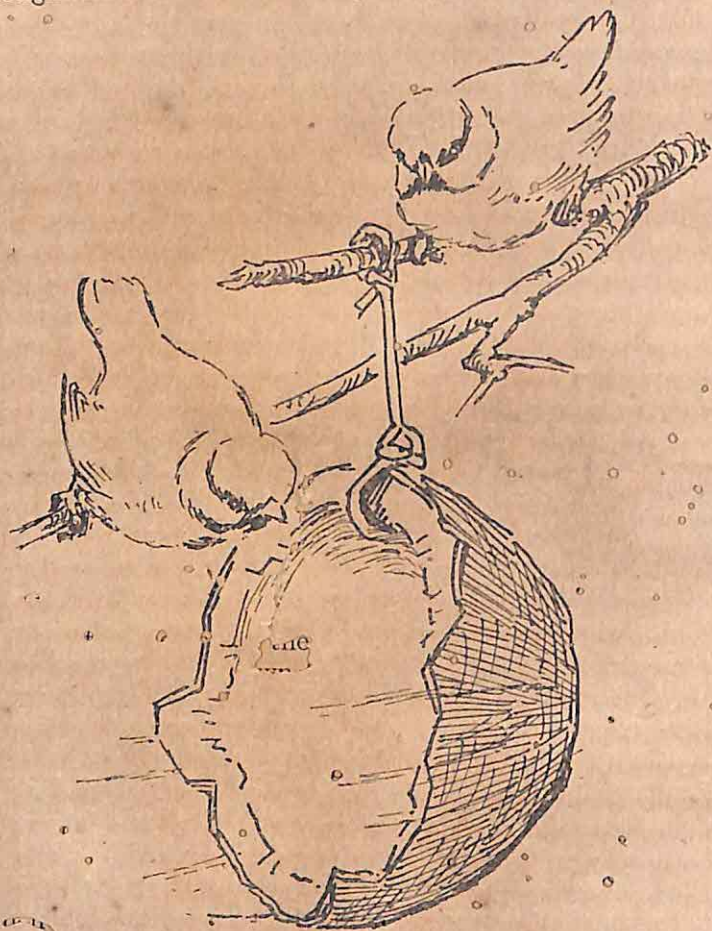


FIG. 2.—BLUE TIT, AND COCONUT

Feeding birds in winter.—In very hard weather, when hedge fruits are covered, and when no chance worm or grub can be unearthed, the children should be

encouraged to feed the birds, and in this way robins, thrushes, blackbirds, finches, can be attracted to suburban gardens. A bird-stand, consisting of a little circular platform—preferably, for cleansing purposes, of zinc, though it may be of wood—mounted on a pole out of the reach of cats, is an easily managed playground fixture, and, if put up in a quiet corner of the school garden, within sight of the class-room window, will be a great delight to the children, who will in this way learn much of bird life. Birds suffer from thirst in frosty weather, and a saucer of water should not be forgotten at any time. They will like some sand, too, to help their digestion. Thus children will come to know the blackbird, with "orange tawny bill," his soberer mate in her brown dress, the thrush, with his sharp beak and spotted breast, and so on. They will also learn to recognise the birds as individuals. They are very apt to imagine that birds fly about in the wide regions of the air over indefinite areas; they will find that, on the contrary, they are very conservative in their habits. This is especially the case with the robin, who likes to settle on a garden, or on some portion of a large garden, for his own peculiar domain. He will fight for it with other robins, and, until the time comes for building the nest, is very unsociable even with the hen. He is very "tame," and does not mind coming quite close to a human friend or into an inhabited room for his food; indeed, he prefers this to scrambling for it at a distance from the door or windows with a mob of other birds.

The blue tit.—In suburban gardens, too, the children may have the joy of seeing the charming little blue titmouse. For this bird a stand is not so good, as he is very pugnacious considering his size. He will show to better advantage and be better pleased with his lot if a bunch of suet in a little string bag or a coconut

with its ends sawn off, or half a coconut inverted, is hung from a bough, where he can peck at it in his own fashion, clinging on to it upside down with his feet, and balancing himself in all sorts of positions. The coconut when empty can be filled with bits of fat or suet, for, as Gilbert White noted, he is "vastly fond of suet." He will show a variety of charming poses, too, if we string up some almonds on a wire for him, and fasten it securely from one point to another. The blue tit is not a shy bird, but in watching him or any other creature the teacher will impress upon young observers the importance of being absolutely still whenever possible. Animals are shy, not of human beings as such, but of movement. The young naturalist must be trained in patience and self-control. Hence for this kind of observation in the home garden or during a walk it is better that one child, or two friends, should be *alone*.

Town children have always the ubiquitous house sparrows, starlings, and pigeons to observe, and they should be set to watch them as they perch and feed. The cock sparrow may be known from the hen by his black throat and breast. Except during the nesting season,

Bird studies for town children. when the young are fed on insects, the sparrow is generally a vegetable feeder, picking up grain and seeds with its hard cone-shaped bill. How does the sparrow move along the ground. Does he walk or hop? Let them compare his movement with that of the starling, also a perching bird, who, however, is so much on the ground looking for food that he walks or runs as a rule. When, however, he wants to move quickly, he hops, the natural mode of movement for perching birds, who, as Mr. Kay Robinson points out, have found hopping on *two* feet the best way of passing from one part of a tree or bush to another. Let the children note the

green and bronzed markings on the starling as the sunlight catches his feathers, and also learn to recognise him at a distance by his peculiar "dodging" gait and pointed wings. In the same way let them notice the pigeons. Do they move over the ground by walking—*i.e.* putting one foot before the other—or by hopping on two feet? What is the food of the pigeon? Notice the movements of its long flexible neck when feeding. On what does a young pigeon feed? Does it require insect food? Notice the heavy flight of pigeons. If they alighted on the ground suddenly with those heavy wings outspread, they would certainly receive a shock. See them, as they alight, spread out their tails so as to slow down the rate of speed, and thus alight more gently. Set the children to find out all they can about pigeons, and let the owner of a "homing" pigeon bring it to school, and let it loose to display its wonderful instinct for finding its way to its home.

Birds' songs in winter.—On mild days in February, or even in January, the song of the skylark will be heard, and the thrush also will begin to sing in February. The robin has sung all through the winter, the starling has chattered or whistled according to his mood, the missel-thrush, or storm-cock, has piped vigorously in stormy weather, as its name implies. Children should not only be trained to watch, but to listen, and in these wintry days of comparative silence they will have opportunities of learning a few songs of birds so as to know them by ear. Soon the birds will be nesting. What can we do to sharpen the eyes of the children as

**Nests in
museums.**

to the chosen home and building fashions of each kind of bird, while at the same time keeping uppermost the feeling of sympathy with a home life which is such a curious and charming reflection of their own? A visit to a museum, as generally managed, is apt to result in a bewildering

confusion of impressions, but a visit made with some *special* purpose—to see the nests or eggs of some birds they have been watching or have met in pictures or stories—may be very profitably carried out. And all London children who have been interested in birds should be taken to that wonderful section showing birds' nests in their natural habitat which is one of the most striking features of the Natural History Museum at South Kensington.

CHAPTER VII

BARE TREES

THE comparative bareness of the face of the earth in winter is not altogether a disadvantage, for whereas in spring and summer the eye is bewildered by the multiplicity of the outdoor sights that compete for our attention, in winter it is possible to isolate the various objects, as it were, and to see them with more distinctness.

Winter is the best time for the study of the characteristic shape and branching of trees, which in summer the mass of foliage disguises. Now the children can be trained in the recognition and appreciation of form, apart from the attraction of colour in its more vivid tones. Every English child should be able to recognise, in winter as well as in summer, the commonest native trees, and also those imported trees, such as the plane and the horse-chestnut, which are so useful in beautifying towns. The method would be to notice some one tree, such as an oak, and make it the object of a winter walk or field-lesson, getting the class to observe it both before and afterwards, and to tell what they have noticed. When the tree is first inspected, the children can discover some of its peculiarities for themselves, and be guided by questions to notice other points. Then ask them to shut their eyes, and try to see a picture of it in their minds. When some one tree has been looked at thoroughly, the class

should be set to discover others that occur in the same walk, or that may be found in the same neighbourhood. A picture or photograph of the tree in its winter habit displayed on the class-room wall will greatly stimulate interest in this search.

Tree-maps.—It is a good plan to have a tree-map of the district, *i.e.* a plan of the fields, woods, and roads near the school, showing by a small circle the position of specially fine or well-known trees. The name can be printed neatly near the circle, or different colours can be used to denote trees of different kinds, oaks, beeches, elms, &c. It is better, however, not to insert these in the map all at once, or indeed to attempt to visualise more than *one* tree at a time; when one has been learnt so thoroughly as to be an acquaintance, the others can be more easily learned by comparison. Nature study depends, of course, largely upon this power of recognising types and divergencies from types—in other words, of finding likenesses and contrasts. But in the case of children it is well to remember the psychological law, “Successive apprehension is clearer than simultaneous apprehension.”

If the teacher himself should need guidance, he can best obtain it in the country from some good-natured country-bred person who knows the lore of the woods and fields. To the London teacher, the gardens at Kew, with their clearly-labelled specimens, are full of instruction, and the South Kensington Natural History Museum has lately followed the example of some provincial museums in providing exhibits of trees photographed in their summer and in their winter habit, and with specimens of flowers, fruit, leaves, &c.

The oak tree.—In the case of the oak, the children will notice first of all the broad branches stretching out from the trunk almost horizontally, and then forming crooks, knee-joints, and zigzags, though still keeping

on the whole parallel with the surface of the ground, except at the top where the growing branches ascend and form the crown. The branches

Mode of branching.

or outgrowths from the great boughs will be noticed, and then the twigs or smallest branches. These are comparatively short, and even in spring the shoots do not lengthen much; hence the

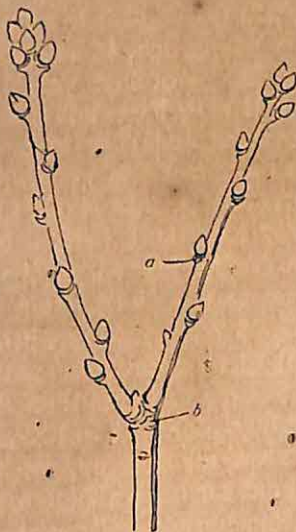


FIG. 3.—OAK.—The terminal bud has not developed, but the side buds have forked vigorously

a.—Bud, with small scar showing position of fallen leaves.
b.—Girdle of scars left by bud scales.

foliage of the oak will be compact and the leaves fairly close together. For the present the children can only notice the small brown buds so closely set on the twig; these will be the future shoots with their new leaves. In the oak these are arranged in a spiral fashion round the twig, the turns of the spiral being widely separated through the length of the

twig, but crowding closely together at the tip. If a thread be started from one bud and wound round the stem, it will have to twine round it twice, and to pass over five buds before it comes to a bud (the sixth) which is directly above the starting-point. If later on the terminal bud of the spiral be examined it will probably be found to have decayed; it is those just behind it that will survive and form those abrupt angles from the parent bough which distinguish the oak.

If the tree is a young one, there will be many of the brown shrivelled leaves of last year hanging upon it, and the children, if they have not observed the fact in the previous autumn, can now notice that each new bud is formed in the upper angle or fork between the old leaf and the parent twig. As Ruskin puts it: "Every leaf has assuredly an infant bud to take care of, laid tenderly as in a cradle, just where the leaf-stalk forms a safe niche between it and the main stem." As each one of these buds may lengthen out into a leafy branch, it is obvious that there might be as many new branches or twigs sent out every spring as there were leaves on the tree in the preceding year. It will be noticed, however, that the buds do not all develop, for the tree has not enough nourishment for them all. Some decay, and some remain in a resting state, until perchance an accident occurs to a neighbouring shoot, when the food supply thus set free is utilised in starting them to grow. Scars will be found upon the twig beneath the buds; these mark the places where the old leaves grew before they became detached in the autumn. The little bud was thus protected from the early autumn rains and frost. How is it protected now? The question may be answered by looking closely at the hard leathery leaves wrapping round the oak buds. The children will find that these are not true leaves, which become green and remain on the twig. They are *scale* or *enclosing* leaves,

which simply guard the bud during its infancy, and then drop off. (The big buds of the horse-chestnut, glistening with varnish, will best illustrate this kind of adaptation.) By-and-by, when the scale leaves have fallen off, sharp eyes can detect on the oak twig *rings of scars*, which are quite different in character from the single-leaf scars, and which make bracelets round the twig at intervals. These are remnants of the bud scales which wrapped the twig round in its infant stage, before it had lengthened out.

The trunk.—As the boughs, especially when burdened with their weight of leaves, are very heavy, the trunk must be correspondingly stout and strong. Let the class notice how thick it is where it springs from the earth; how it narrows as it rises and then forms a column of about the same thickness throughout its height; how it is swollen at the points where the boughs are sent off. If a felled oak sawn across can be met with or a specimen procured from a timber-yard, the children can be shown the rings in the trunk, the number of which tells the age of the tree. They can be told that the trees "rest" in autumn and winter, and that by the time the new wood is formed in the spring the old wood has changed colour. The bark will be observed; in an old oak this will show ridges and furrows due to the pressure of growth from within.

Galls.—Another feature of the oak in winter will be the hard woody marble-galls, which the younger children will mistake for some kind of fruit. They will perhaps find the true fruit—brown and polished acorns that have slipped from their cups—lying below. The explanation of the "galls" may be reserved for the present, until the children have had time to watch, count, and describe the various creatures, small as well as great, that haunt the tree in spring and summer, and also the various structures that appear upon it.

Variation in "habit."—When the pupils have noticed the "habit" of the oak as it grows in the open, they should be taken into a wood or plantation where it is competing with other trees growing close to it. Here they will find that it alters its ways. The trunk is much less stout and rises in a straight column, and the branches, instead of beginning low down, are borne towards the top. In such situations the terminal buds do not die, but lengthen and push upwards, while it is the lateral ones that are generally starved and undeveloped. What is the oak tree seeking, that it thus behaves so differently? Its needs are *light* and *air*, and although in an open field it prefers the spreading habit we have noticed, it will adapt itself to circumstances in order to secure these essentials.

Comparisons with other trees.—When the children are familiar with the oak, they may compare it with other trees. They will notice the taller and more slender growth of the elm, whose myriad delicate twigs,

The elm. hidden in summer by the rounded masses of foliage that clothe each limb and the lofty crown show like lace-work against the sky. Often one of the larger limbs will be missing, for the boughs of the elm are liable to snap. It has a rough corky bark, forming large coarse flakes. The ash can be recognised

The ash. by its straight trunk, very smooth and grey in young trees, and by its branches taking a beautiful upward curve like that of the arms of a candelabrum. But its twigs, sturdy, flattened, and rather blunt, are tipped not with the colour of flame, but with ebony, for its triangular buds are of a deep rich black. Each bud is borne on a curious little bracket-like projection of the twig. These black buds are in opposite pairs, each pair being at right angles to the pair above and below it, or as the children may say, "half-way round" the twig.

The winged fruits of the ash—"locks and keys," as the country people call them—cling to the bare trees in winter until they are forcibly rent away by high winds.

The beech. The beech has a grey smooth trunk, generally columned at the base, for its great boughs support themselves, as it were, by union with the parent trunk. If a beech grows in the open,

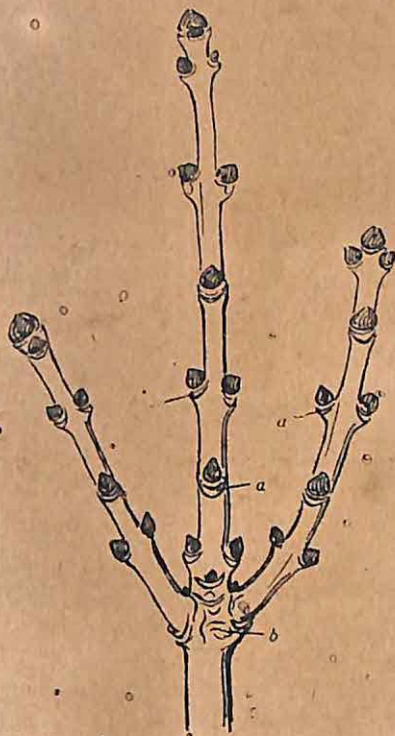


FIG. 4.—ASH, showing terminal and opposite buds
a.—Scars, showing position of fallen leaves.
b.—Girdle of scars left by scales of last year.

the middle boughs will be seen to thrust themselves out horizontally to avoid being overshadowed in summer by

the boughs above. These grow upwards towards the light, forming a huge crown. The lower and shorter boughs, though at first they spring from the trunk in

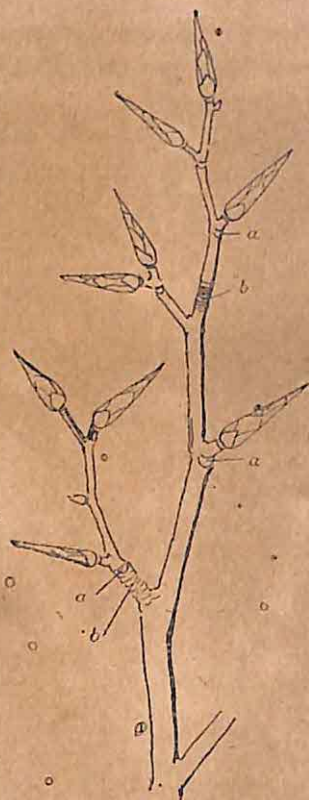


FIG. 5.—BEECH

a.—Scar left by last year's leaf.

b.—Girdle of scars left by bud scales of previous year.

an upward direction, seem to realise that their best method is to dip down a little so as to catch the sun and air which will reach them slantwise from below the middle boughs. But, like the oak, the beech changes

its habit when it grows in the woods, and thrusts both its trunk and its branches *upward* as far as possible so as to try to overtop its competitors. The buds are long, slender, pointed, and brown, arranged alternately one on each side of the twig, and, as in the case of the oak, young beeches such as those clipped to form hedges will be found to keep the bright russet leaves of last year clinging to their boughs through the winter, and giving a warm tinge of colour to a sombre landscape.

CHAPTER VIII

SPRING FLOWERS AND THE PROVISION MADE FOR THEM

Cultivated Bulb Plants (1)

IN the preceding autumn, or even during the winter, the teacher will have arranged for hyacinths to be

Hyacinths grown in pots for indoor observation, and
in the he will also grow some in water. In
schoolroom. managing these last, it must be remembered
that the bulb must not be plunged in the

water itself. It must clear the water in the neck of the glass, and if necessary be separated from it by a layer of soft moss. The vapour rising from the water is sufficient to stimulate growth. The best method is to keep the bulb in a cool dark place until roots are formed, otherwise the upper part may grow too fast in proportion to the roots, which are, of course, necessary to maintain the vigour of the growing shoot. When the roots are formed, bring the hyacinth into the light; it now needs no attention beyond adding a little water to replace that lost by evaporation, and when the leaves are formed they must be occasionally cleansed from dust. The water should be soft rain-water if possible. The children will be interested to see that the plant thrives in water only, and will be able to note its growth from stage to stage. Compare with an acorn seedling which is also grown in water, but which soon perishes. Reserve for the present the consideration of why the acorn grows at all under such circumstances; and con-

central attention on the prolonged life of the hyacinth. Let the children make out its parts: the slender roots reaching down into the water, the swollen part whose nature perhaps they are puzzled to determine, though they may say it is part of the root, and then the long green leaves standing up round the flower bud which gradually opens into a cluster of bell-like flowers, at first erect, and afterwards drooping slightly from the stem on their long stalks, each flower having a whitish papery leaf (bract) attached below it.

The question of dissection.—The question now arises, how far should children under twelve be allowed to dissect living flowers whose value to us lies in their beauty? The answer may perhaps be given by stating a point in æsthetics. It is repugnant to a right-thinking person to see a child, or indeed any one, destroying life *without reason—i.e.* for the mere sake of destroying. A manuscript of the New Testament, dating from the sixth century, has a story of our Lord beholding a man working on the Sabbath, and saying to him: "Man, if thou knowest what thou art doing, blessed art thou; but if thou knowest not, thou art cursed, and a transgressor of the law." We may apply this principle to the destruction of life, animal or vegetable. If we take life according to reason, *knowing what we do*, whether for food, clothing, or the advancement of knowledge, we are justified, in that our motive is well-being. If we do it in a careless, wanton, brutal fashion, without that *consideration* which such acts should involve, there is something monstrous and revolting in us. It is because intellectual consideration cannot be expected from young children that Kindergarten teachers are right in restraining them from pulling flowers to pieces or impaling butterflies; such acts are rightly regarded as savage instincts that have to be restrained. The only sure way to restrain these is to cultivate opposed tendencies. To

apply this to our hyacinth bulb—the very little ones may be interested in watching and admiring the plant, and then the instincts of possession and of doing may be brought into action so that they may be anxious to rear bulb plants of their own. The elder children, in whom the teacher feels the instinct of respect for beautiful forms of life to be firmly rooted, and who are capable of a genuine intellectual curiosity, may be given for examination a plant which is past its best bloom and is seeding.

Analogy with the onion.—Both for these elder children and for the classes next below them, it will be quite allowable to sacrifice a food-plant—the ordinary onion. Have ready for comparison a spring onion of this year, and an onion of this year that is beginning to sprout. Let the children notice the long green leaves of the spring onion: they shoot from a little white disc or cushion above the roots. Now show the likeness between this and the sprouting common onion, which last year was in the same condition as the spring onion. Make a vertical section of the sprouting onion. The outermost leaves have died off at the top, and the lower parts have become brown and papery. Their veins can still be seen, but their texture has altered. Next we come to the inner leaves. The tops of these leaves have also died down; though search among a stored crop or in a greengrocer's basket will often yield specimens where they remain as long brown wisps, the outer clasping the inner. But the lower parts, the bases of last year's leaves, have become thick, fleshy, and juicy; hence the swollen appearance of the common onion as compared with the spring onion. They form a series of overlapping coats, touching one another, it is true, but nevertheless separated by a kind of sheath, so that each leaf can be marked off from its neighbour. All these rise from the little swollen knob at the base. In the middle of this

knob other leaves arise, which, unlike the others, are not broadened out, but are pushing upwards. There is a glistening white sheath something like the lining of an eggshell round this growing part also, and if this be slit open, yellowish-green leaves can be seen within. So then we have:—1. Outer papery leaves, which do not grow. 2. Inner fleshy leaves, which do not grow. Both these are remnants of the green leaves of last year. 3. A fresh set of leaves which *do* grow. 4. A short cushion-like stem to which all these are attached. 5 (fig. 6, p. 52). Roots growing from the under side of the stem. Now cut the onion transversely and let the children recognise the same parts. The outer brown coat may be gently raised by pulling out the upper free edge as one would lift a cap by the tassel. The inner fleshy leaves may be raised one by one in the same way, each slipping over the head of the growing shoot, round which they form a series of such caps and which is at last seen standing up from the lower part of its bulb, like the true bud that it is. Let the class draw what they see in the case of both sections.

What a bulb is.—The children can be told that when we speak of a bulb we mean a very short stem wrapped round by fleshy leaves which were at one time the basis of foliage leaves, but have now become storehouses for the plant. We must not let them suppose that it is necessarily an *underground* stem, because later on they may see little bulbs (bulbils) in the axils of the foliage leaves of the tiger lily, which are used to produce new plants.

The hyacinth a provider.—Let the children now compare the more irregular wrappings of the hyacinth bulb, due to the unequal dying down of the outer leaves, with the brown shining coat of the onion. These outer coats are also protective; for further defence, there are in the hyacinth, as in many other bulb plants, poisonous juices which protect it when in the ground from

the nibblings of animals. An instance occurred in the family of the writer of several persons being made ill through an unobservant maid cooking hyacinth bulbs which happened to be stored near some onions. The solid part of the bulb is made up of fleshy scale leaves, and the central part behaves in the same way as the sprouting

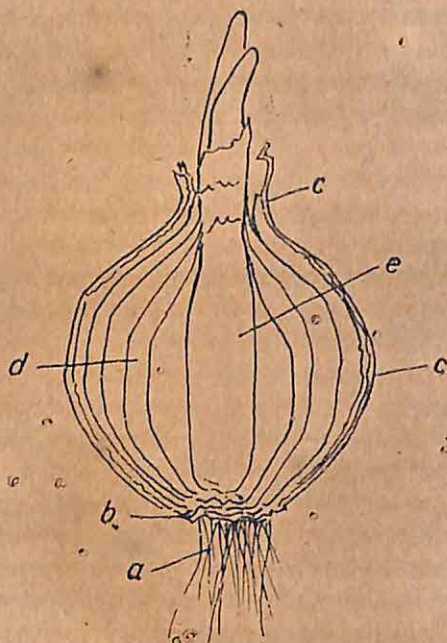


FIG. 6.—SECTION OF AN ONION

- a.*—Roots. *b.*—Stem.
c.—Papery bases of last year's leaves.
d.—Fleshy bases of last year's leaves
e.—New shoot with fresh leaves.

shoot of the onion. The children will know that we take advantage of the juiciness of the onion scale leaves, and if they nourish us, may they not also nourish the plant? They will be pretty certain of this when they note that as the shoot lengthens out in an onion

not planted, the scale leaves are manifestly the worse for this change; they become loose and flabby. They will realise, therefore, that these plants are providers—laying by a store of food for the needs of their young buds. Both foliage leaves and flowers require much nourishment, and in the case of bulbs this nourishment is packed away in these scale leaves, whence it is drawn to the stem and so up to the shoot. Thus we may have the flowers and fragrance of the hyacinth even in midwinter.



FIG. 7.—OLD HYACINTH BULB WITH NEW BULB

Life history of the hyacinth.—To pursue the life history of the hyacinth. Let the children make drawings of the plant in different stages. Let them look for hyacinths grown out of doors. When the plant grown in a pot has blossomed the leaves will continue to be green for some time; they are employed in making a store for another year. The plant raised in water is probably exhausted, but when the leaves of the potted

specimens have died down, the bulbs should not be thrown away, but stored in a dry place and planted next October out of doors, where they will bloom next spring, though not so luxuriantly as before. Let them examine the bulbs for the new buds, which are formed on the cushion at the base of the larger bulbs, between the same leaves. These are called off-sets, and gardeners can raise new plants from them. The children will know that onions are raised from seed, and they will plant onion seed in their own gardens. They will ask: Does this happen in the case of the hyacinth? Tell them that the Dutch people, whose soil and climate suit hyacinths, raise them both from seeds and from the little off-sets. But hyacinths raised from seed do not flower until three or four years after planting. Nearly all the hyacinths grown in England come to us as bulbs from Holland.

Questions of plant physiology.—The question may now arise, *How* did the plant form the food that it laid by in the bulb? To answer is, of course, extremely difficult, for it would mean making clear the process of assimilation—i.e. the decomposition of the carbon-dioxide of the air, during sunlight, by those tissues of the plant that contain leaf-green (chlorophyll), and the chemical combination of the carbon with the water that has been pressed up from the root, resulting in the formation of starch. The superfluous oxygen is given back to the air, and thus green plants are purifiers of the atmosphere. Plants also take in oxygen from the air as we do, in the process of respiration, but the balance is in favour of the oxygen!

Work of leaves.—Now, it is obvious that not much of this can be explained to a child under twelve. But if the function of the leaves be not dealt with at all, while on the other hand he sees how much is done for the roots in digging, hoeing, weeding, watering, manuring, &c., he will

naturally think that the nourishment of the plant depends entirely on the soil, and he will lose the significance of the marvellous adaptations of foliage leaves to the need of securing light and air. Yet he cannot understand the chemical processes involved; carbon-dioxide and hydrogen are mere sounds to him, and it is of no use to drop iodine as a test for starch until he knows what is the composition of starch, and why it is a foodstuff.

Moreover, in the case of the onion, the stored product is not starch at all, but a form of sugar. Nor are matters much helped by saying, as some books recommend, that the green leaves are the "kitchens" of the plant. One would be curious to see, if it were possible, what kind of image is conjured up in the child's mind by the association of this metaphor with the look of a daffodil leaf. On the other hand, children hear about the invisible air which surrounds them, and recognise that it has a great importance in affecting the health and the doings of people. It is better, therefore, to keep to analogy and to say to a child, "Plants need air as we do, and the leaves take in air for them just as your lungs take in air for the rest of your body. If the leaves are covered with dust, the plants become unhealthy. That is why mother washes the leaves of the aspidistra or the india-rubber plant, and why we cleanse the leaves of our hyacinth with a wet camel's-hair brush. But besides air, the plant wants food, as you do. Some of the food comes from the root, as you know, from the water and other substances in the soil, and it rises up through the stem to the leaves. [The mystery of root-pressure, so fascinating to grown people, does not exercise the mind of the child.] This liquid food would not be enough for a growing plant that wanted to make flowers and seeds. The green

Explain
not by
chemistry;

nor by
metaphor;

but by
analogy
with
child's
own life.

leaves therefore have the power of taking in food from the air in a wonderful way which you will understand when you are older. The green leaves of a hyacinth and an onion have been at work to make the juice which is stored in their bulbs. In the case of the onion we rob the plant; in the case of the hyacinth, we let it carry out its intention of providing for its blossom and seed."

This simple explanation, like many explanations given to children with regard to their own life processes of digestion, &c., must necessarily be partial and somewhat "over their heads." But it should at any rate teach them to regard plants not as mere passive objects, but as engaged in something similar to the two great human occupations which the pupils understand—getting food and taking care of children.

CHAPTER IX

SPRING FLOWERS AND THE PROVISION MADE FOR THEM

Cultivated Bulb Plants (2)

THE question may now naturally be asked: Do any other spring flowers besides the hyacinth owe their power of blossoming so early to underground stores?

If this kind of work is quite new, the teacher must produce a little collection of bulbs and let the children make

Recognition of the bulbs. sketches of each specimen in pencil and in water-colour. But obviously the best time to do this is before the autumn planting.

Let a record then be made of the outward appearance of the bulb by means of a tinted drawing and its name be printed below. Let the children leave a space in their books in which to make sketches of the shoot, with its leaves and blossoms when they shall appear. It is good, moreover, to have one or two bulbs of each kind in store, so that the mental images can be revived, and the growth of the plant be pictured in a continuous series.

The snowdrop.—Let the children accordingly observe the small bulb of the snowdrop, shaped somewhat like a hazel nut, with dry, brown wrappings. It behaves precisely in the same way as a hyacinth bulb, though it does not lend itself so readily to forcing. It comes slowly to perfection. "In the first year it is a chicken bulb, in the second it has a chicken bulb of its own, and in the third it flowers." If grown from seed, the time is longer still. There is something almost mys-

terious in the way in which the shoot pricks through the soil. There first appears a papery sheath, drawn over the leaves and flower shoot like a waterproof hood. This delicate thing shows through the coarse mould in February, sometimes piercing the snow. Tell the children the French name of the plant—*Perce-neige*—the snow-piercer. Presently the sheath bursts,

Sheath

leaves and

foliage

leaves.

and we see within two straight, narrow leaves, and between them the flower bud.

The flower stalk grows at first much faster than the leaves, and lifts up its blossoms to the air and light, though just before it is

ready to open it takes care to let the bell of the blossom itself curve downwards to preserve the anthers from wet.



FIG. 8.—PROTECTION OF ANTHERS FROM RAIN.

There is another and smaller sheath on the flower stalk which, like that of the base, has for its work to *protect*. In this case it is the flower bud which is to be protected, while the sheath at the base protects the whole shoot and afterwards its withered base helps to clothe the bulb. The flower bud soon lengthens out beyond its sheath.

The long, narrow leaves should be looked at carefully, and the ridge down the back and the white furrow down the centre should be noted. Notice how they clasp the stem at the base, so that any rain falling upon them, as upon hyacinth or tulip leaves, must be conducted to the roots, which stretch downwards into the soil in a straight line below the bulb. The corolla is seen to be in six pieces; three of them stand outside the others, and these three are pure white. There are three inner ones, half the length of the others, and these are tinged with green. In a first course there is no need to differentiate between sepals and petals—"the circle of coloured leaves around the flower" is the best description; but it is well even at this stage to say that the more important parts—the essential flower—are within. This can be done when the children have noticed the seed-case—a swollen green knob below the white flower. Within the white circle may be found the three-forked stigma rising up from the roof of the seed-cases. There is also a little pointed cone of anthers, consisting of tiny pockets open at the top. When the children seem to be trying hard to make out these structures lend them a hand-lens, which is to Nature study for young children what the microscope is to the student of botany, an instrument to be produced when the need of it is felt.

Kerner, in his "Natural History of Plants," has pointed out that flowers which are solitary, like the snowdrop, usually last for a long time before fading. He surmises that the reason is that such flowers have less chances of setting their seed than those with many heads of blossom, and spring flowers moreover are liable on many days to lack insect visitors to carry their pollen; hence they have a longer time in which to use their chances. This need not be explained to the children at present; but the usefulness of these bulb flowers for decoration

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*Snowdrop, perianth
drooping, forming bell.*

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on account of their "lasting" qualities is quite noticeable, and the children can be set to watch and record in their note-books how long the later flowers last—the geranium, meadow-sweet, evening primrose, for example—in comparison with their spring favourite.

Snowdrops, known to town children only in gardens or in the florists' shops, grow wild in some counties of

Wild snowdrops. England, forming beautiful white sheets in an orchard or meadow. Let them

imagine the bulbs lying below in the ground all the winter, deep enough for warmth and yet not too deep for the air to reach them when it is time to wake up. They will be interested to hear that this dainty flower has its formidable qualities. It is said to be "pest and rodent proof. Neither rats nor mice, nor moles nor rabbits eat snowdrops, neither bulbs, nor leaves, nor roots. Even snails, woodlice, earwigs, worms, and feathered things leave the snowdrop to its own beautiful habit of peeping up through the snow like a sheeted ghost, or rather like the fair maid of February that it is, to see how the world goes at that early season of frost and snow and harsh wind."

The tulip.—As a contrast to the modest snowdrop we may take the tulip, which surely may be called the King of Bulbs. Let the children notice the very tough brown coat of the bulb itself—its long and broad leaves straight and uncut, like those of the hyacinth and snowdrop, its magnificent blossom, also with six pieces, forming a gorgeous cup around the three-knobbed pistil and the six stamens. Why are the colours so beautiful, and why are there lines leading

Its sensitiveness.

towards the centre of the cup?

The tulip is specially interesting as a sensitive plant. It does not protect its anthers by drooping them downwards as do the hyacinth and the snowdrop. But bid the children watch to find out how

its petals open quite widely in sunlight, or if brought into a warm room, but fold in cold, cloudy weather and towards evening.

The daffodil or Lent lily has a large, egg-shaped bulb, also poisonous. It is pulled down by the roots a long way below the surface. There are five or six flattened leaves grooved in the centre like the snow-drop leaves. The leaves do not at first grow so fast as the flower, but they continue growing (and hence making and storing food) after the flower has



FIG. 9.—PROTECTION OF ANTHERS FROM RAIN

faded. The daffodil flower would be beautiful even were there not the lovely crown at the mouth of the flower-tube (the teacher will note that this "corona" is merely an outgrowth from the six segments of the perianth). Ask the same question that was asked with regard to the tulip as to the probable reason of the richer colour of the corona; not, however, with a view of receiving an immediate answer. Ask the children to reserve their answer until a little later. Note also that the corona by its forward projection acts as a shield to the anthers. The daffodil is only a species of

narcissus, and the various forms of the corona should be looked for in other species. In the jonquil the whitish bract encloses not one flower, as in the case of the daffodil, but several. The bract, by-the-bye, is sometimes a puzzle to children; they may be helped by thinking of the flower as a bud and comparing it with the buds of trees. In both cases the bud is protected by a special kind of leaf—the bract.

The crocus must receive special attention, for it is not a "bulb" at all. There are no scale leaves, and all the nourishment is packed in the short, stumpy stem itself, called in this case a corm. The corm has a tunic or coat, which consists of the bases of the true leaves and of the leaf sheaths of a past year. Afterwards this slips upward, showing the hard, white substance beneath. A new corm is produced every year at the summit of the old one. The old one dies, and the roots pull the new one down to its proper place in the soil. The bud is sheathed by special leaves; the inner sheathing leaves are longer than the outer and more like true foliage leaves. The true leaves are very narrow, almost like grass blades, but stouter, and they have a whitish strip running along their entire length. The blade is rolled backward a little on either side of this white strip. The leaves continue to grow after the plant has flowered; in fact, until the new corm down below is ready for its work next year. Gardeners tie up these leaves in knots so as to prevent them from hanging untidily over the borders; they do not cut them off because they are still at work gaining food from the air.

The flower also lengthens in an extraordinary manner; the bottom of the coloured tube rests upon the corm under the soil, and there the seed-bag is hidden until about midsummer, when the seeds are ripe. Then it may be seen above the ground. The long style runs up the whole length of the tube, and its branching

tip may be seen in the throat of the flower. This throat shows always more or less of orange, whatever the colouring of the whole flower may be. The crocus has only three stamens, and over these the six petals close in wet weather like a rounded tent or hood.



Crocus vernus
before forming hood.

FIG. 19.—PROTECTION OF ANTHERS FROM RAIN

Crocuses are now happily planted not only in formal borders but among grass, recalling Tennyson's line:

And at her feet the crocus brake like fire.

Let town children be taken to see them on the slopes of park lawns. If possible, plan an excursion to woods where the "wild hyacinths" are blossoming. But the so-called wild hyacinth is really a squill, or scilla; it is different from the hyacinth in that the bells grow from one side of the stem only, and the segments extend nearly to the base of the bell. These, too, have survived the underground perils of the winter, and produce their lovely mist of blue in the woodlands so early because they have stores of food laid up in their hidden bulbs.

Generalisation.—The teacher may now feel that the time has come to review what has been gained so far. The children have learned that plants *live*, that they need food as children do, and that they *acquire* food through their roots and leaves. Also they have the art of storing-up food for the future.

Among the bulb plants there are important uniformities to be detected. The name monocotyledons is of course not yet intelligible, and therefore should not be given; but to form a basis for future work in classification the children should be set to compare the plants and so find out that:—

1. The leaves are long, with uncut margins, and have straight (parallel) veins.

2. The coloured parts of the flower, the stamens and the stigmas, are in groups of sixes or threes.

It is also well, with a view to classification, to get the children to memorise, by drawing, the position of the seed-vessel with regard to other parts of the flower.

Design.—The above essential characters will be enforced not only by observation but by art work. These bulb plants, with their bold, simple yet beautiful outlines, lend themselves naturally to exercises in drawing, painting, and design, and their influence is everywhere to be found in modern decorative work. If design is attempted, the teacher must point out that no design can be good which contradicts the essential habit of the plant.

Insect visitors.—While the flowers are in bloom the children should be set to observe what insect visitors they have. They will notice hive-bees, humble-bees, butterflies, moths, beetles, and smaller flies whose names they will not know. The size and simple structure of the tulip render these visits easily observable even by small children. They may be allowed to experiment for themselves, and obtain pollen from the anthers with the tip of a pencil (Chapters XXV and XXVI).

Their purpose.—Pollen forms part of the food of insects; they also like honey. The tulip, though it has abundant pollen, has little or no honey, neither has the hyacinth; but the tissues of the flower of the latter are sugary and are often bitten through by insects. The crocus has plenty of honey welling up in its long tube, the daffodil has honey in the stalks (filaments) of its stamens, and the snowdrop produces it on the inner side of its perianth leaves. Why does the plant provide these dainties for chance visitors? The children may be told that the great task of the plant is to produce seed, from which fresh plants can be raised; that this seed cannot be produced unless pollen falls on the stigma; and further, that, as a rule, better and stronger seeds are formed if the pollen comes from some other plant. Hence by colour, honey, scent, the flowers attract insects to visit them and to carry their pollen away to where it is wanted. They may see for themselves how a large insect like the bee is dusted over by pollen from a tulip. Young children are not interested in questions of fertilisation—their interest lies wholly in the appetite of the insect; but the elder ones may be set to watch these flowers throughout the year to find out any special contrivances for securing this carriage of pollen.

Bulb culture.—Finally, encourage the children to buy bulbs and rear them for Christmas presents and birthday presents in the spring. The teacher in a well-to-do school can buy a little stock from a trustworthy seed merchant and retail them. In poor schools, let each class, if there is not a bulb-bed in the garden, have at least one or two specimens whose life-history they may watch. The connection may not be so very remote between the Dutch enthusiasm for order, brightness, and cleanliness and the Dutch fondness for these dainty creatures of the spring.

CHAPTER X

SPRING FLOWERS AND THE PROVISION MADE FOR THEM

3. *Wild Flowers*

IN their study of bulbs the children have become acquainted with stems which, unlike the stems they have been accustomed to see, have taken to an underground existence. The spring flowers of the snowdrop, hyacinth, daffodil, tulip, and crocus have been nourished on a store of food laid up in the bases of last year's leaves surrounding the underground stem, or, in the case of the crocus, in the stem itself. The question may now be put: "How are those spring flowers provided for that we find blooming early in the year, in hedgerows or copses, or in the open fields?"

The list of the flowers that may be found by the children from January to March will be a short one, but it will be sure to include the lesser celandine, Wordsworth's favourite flower:—

Ere a leaf is on a bush,
In the time before the thrush
Has a thought about her nest,
Thou wilt come with half a call,
Spreading out thy glossy breast
Like a careless prodigal;
Telling tales about the sun,
When we've little warmth or none.

The "tale about the sun," told by its glossy yellow petals, may lead the children to call it a buttercup. But

though it belongs to the same group of plants, it is not a buttercup. Let them study its heart-shaped leaves, which, by-the-by, are so daintily poised and folded when in bud. The leaves of a true buttercup are always more or less divided.



Lesser Celandine

FIG. 11.—THE LESSER CELANDINE

These hardy plants can, with care, be safely transplanted at any season of the year, and the teacher may dig up one plant from the wayside clump and give it a home in the "wilding" or "weed" portion of the garden. Before planting, let the children look well at its roots. They will notice a short fleshy stem, root fibres, and also fibres bearing many little oval bodies rather like figs in shape; but reminding us in their arrangement of a potato plant which has been unearthed. These root branches are swollen because they contain stores of food with which to nourish the yellow star of blossom

Its store-house.

that the celandine lifts up for us in March. If we take up the plant when the flowering is over, we shall find that these little tubers, as we may call them, have become shrunk and flabby, which tells us that they are of no further use; new ones, however, will be forming to take their place. During the transplanting, the class will have noticed how very easily the little tubers become detached; they are easily broken off from the parent plant by a little loosening of the soil, and are washed away by heavy rains. These little tubers are so plentiful that they form a miniature "potato rain" as it has been called; and since they have the power of producing fresh plants, we can quite understand how it is that we see the celandine growing in gay clumps—a crowd together.

Let the children notice the blossom itself. They will find a new feature not seen in the bulb plants—viz. an

Its flower. outer cup of sepals—forming a *green* flower circle. These are from three to five in

number. The golden petals are much more numerous. (Notice that the outer sides of these are somewhat green like the sepals.) At the base of the petals, the elder children can make out, with a lens, the little scale or pocket for honey. There are a great many stamens, and many stigmas showing the summits of tiny seed vessels. The plant, as will be seen, does its best to attract insects by its yellow, glossy petals, its pollen, and by the little honey bags; but insects do not always care to travel into the somewhat shaded places where it grows, so, as its seeds are rarely set, the prudent little plant makes the extra provision we have noticed in its root-tubers, both for a spring store of food and also for giving a start in life to fresh celandines. To make matters still more sure, many celandine plants produce in the axils of the leaves small brown egg-shaped bodies, which fall off and give rise to new plants.

Coltsfoot.—On waste pieces of building land or on railway banks the children will find the coltsfoot. At first sight it has not much grace of appearance, though its yellow colour—the most cheerful of all colours, according to the philosopher Goethe—is attractive enough in the still gloomy days of late winter. “Dandelion!” the children will perhaps say, but the big rosette of deeply-cut dandelion leaves, lying close on the ground during the winter, should be pointed out to them. Apparently the coltsfoot has no leaves at all; its erect stem has a curiously naked appearance. It thrusts itself up from the coarse clay which is its favourite home, erect, covered with woolly hairs and with purplish scales, bearing aloft its tufted golden head. Let them note, in connection with their observations of the sun, how this flower is turned to the sun at all times of the day.

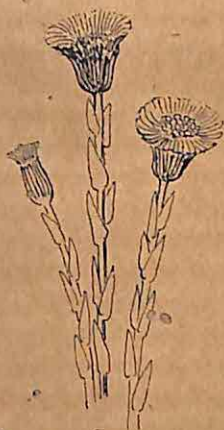


FIG. 12.—COLTSFOOT

In this case, instead of transplanting, it will be more interesting to mark the place by a label and return from time to time to watch its behaviour. In due course it will scatter its feathered seed,

and then, at a little distance from the place where the stem rose, will be seen a set of broad thick leaves, felted underneath with woolly hairs, which were not there when the plant first blossomed.

If, now, we begin to dig, we shall find that the coltsfoot "scape" was supported by a stout reddish underground stem which travelled and bored its way through the earth, and at a little distance from the flower-shoot sent up the leaves. The yellow-headed scape

Its store-house and stem.

was produced by aid of the nourishment contained in this stem; but as there was not enough for both leaves and flowers, the leaves had to wait until the flower had safely ripened its seed. Now the leaves will set to work to manufacture a fresh stock of food to be stored up in the underground stem for next year. Such horizontal stems, bearing rootlets from their lower, and leaves and flowers from their upper surfaces, are called root-stocks.

The coltsfoot is, of course, a composite flower; but it is, perhaps, better to leave the investigation of all that this implies until the pupils can study a larger flower—say, the ox-eyed daisy or the sunflower. In this, as in all cases, much depends on the age and previous training of the children. For quite little children it will be sufficient that they can recognise the flower as it grows, and are able to draw it. Elder children are capable of being interested in the problem of how it manages to get its livelihood and provide for its offspring. When they notice its structure, as compared with that of the tulip, for example, they can be told that a number of little flowers club together for the sake of attracting insect visitors.

The wood-anemone.—As a contrast to the sturdy coltsfoot, our next study may be the fragile wood-

anemone—the wind-flower—so called because of its slight, bending poise, which makes it quiver and sway in the least breeze. So frail is it, that it is of little use to send it to town schools from the country; but fortunately it is very common, and can easily be found in woods within the range of a half-day excursion. It flowers in March. If some budding specimens can be noticed, the children will detect the absence of a green enclosing outer circle such as they found in the lesser celandine. The sepals have, in fact, become petaloid in order to help attraction; there are no petals proper. The inner side of these “petaloid” sepals are of a pinkish purple, thus procuring a little heat for the blossoms, and one or two of these will be seen wrapping round the others in the bud for the sake of protection when it is specially needed. When the flower opens, the lobes of the corolla are seen to be of the most delicate white, dashed with pink; they give out a faint sweet scent. This, as well as the pale glow of the flowers, attracts insects to the somewhat shaded copses where it grows. Kerner points out that the white corolla-leaves are so fragile that an alighting insect such as a bee or beetle would be heavy, and bear them down. But the centre of the flower, consisting of a bundle of stigmas standing up in columns, is much more solid, and forms a kind of platform on which the insect may alight. Further, there are lines and markings on the corolla, pointing towards the centre, and suggesting to the insect where it would be well for him to settle. Round about this columnar platform are rings of stamens, so that an insect, thrusting himself amongst the anthers, gets well dusted with pollen. The anemone has no honey to give, but from March to May it offers a feast of pollen—the “bread” of its visitors.

The leaf-stalks are not nearly so long as the flower-stalks, and bear leaves with three-cut divisions. But

let the pupils notice the three large-lobed leaves on the flower-stalk itself. They will have found that flower-stalks often have special leaves of their own from the axils of which they come. These are called bracts. In the hyacinth, &c., they are whitish, in the coltsfoot purple-brown, in the dandelions the bracts come up closely round the flower-head. But here, in the anemone, after the flower-head has lengthened, they form a kind of graceful mantle, relieving the eye as it travels up the long flower-stalk to the delicate cap that crowns it.

Its store-house.

If, now, both the flower-stalk and the shorter true leaf-stalks be traced downwards, they will be found to proceed from quite a stout, underground rootstock, with rootlets growing from its under side. The early bloom, then, was possible on account of the persistent rootstock, which, stored afresh by the leaves, will lie hidden all through the summer, autumn, and winter, until March comes round again.

The marsh marigold, or kingcup, is not at first sight much like the anemone, but it belongs to the same order, and has similar devices for making an early display. It attracts by turning its sepals into the giant or "king" cup of glossy gold. It has roundish leaves, not cut and slight like those of the anemone; but solid-looking and fleshy, as is generally the case with plants growing in marshy places. But, like the anemone, it grows from a thick, boring rootstock, which forms a store for provisions to support future flowers and leaves.

The primrose gives opportunity for noting both storage and attraction of insects. The sight of wild primroses growing is in itself worth the aim of a spring excursion, and gives an opportunity for training the children to admire the blossoms in their natural surroundings, instead of ruthlessly gathering armfuls without any purpose beyond that which is given by the

instinct of accumulation. A close observer of Nature has said: "There is no surer sign of the craving of Its habits. most plant-life for sun and air than the way the primroses blossom thickly among the young underwood shoots weeks before they appear in the high wood. In the highest wood they are scarcely out till May. Among the one-year-old shoots, which is

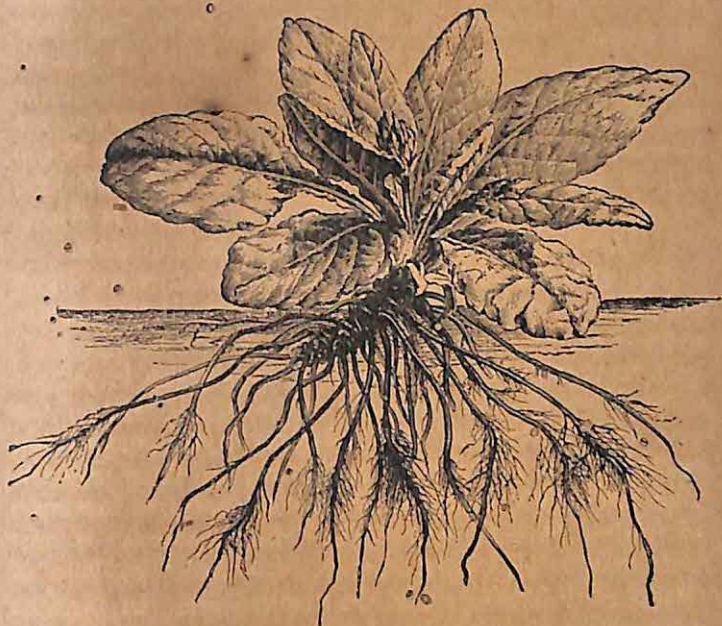


FIG. 13.—PRIMROSE PLANT

practically open ground in early spring, they make a brilliant show in very sunny exposures before March is out. The wind cuts hard in such spots before the young underwood shoots have a leaf, and there is no undergrowth of wood grasses, but the flowers are not hurt by the cold, if they have sun and free air."—DEWAR, "The Fairy Year."

The flower-stalk and the rosette of wrinkled leaves are said in botany schedules to be "radical" in origin ;

Its store-house.

they do not, however, come from the root, but from a short, thick underground stem (rootstock) which bears the flowers and

leaves of the present year at its growing tip. When the pale yellow flowers emerge from the green hairy calyx, the children can see that the five petals are combined

The flower.

at their bases to form a tube, but they spread out above into a kind of salver.

(The presence of the calyx and the number of parts in the flower should be compared with these particulars in the bulb plants.) In the centre of the salver, at the top of the tube, they will find either a "pin" (the stigma) or a bunch of "thrums" (the anthers). "Thrums" is a Scotch word for short ends of wool.

The question of cross-fertilisation.—One hears many lessons to young children on the primrose in which the order is given as for drill : "Slit open your primroses !" and then follows an attempt to drag these immature minds through the pathway of investigations on the cross-fertilisation of the primrose that needed the patience and ingenuity of a Darwin for their prosecution, and that are still occupying the foremost botanists of to-day. We do not think that the attempt is ever successful with young pupils, even with the help of blackboard drawings and clear exposition. In the first place, the great element of interest in cross-fertilisation as a device for securing the fittest propagation of kind, though naturally of great significance to the adult who realises its importance in all departments of organic life, is neither to be expected nor desired in the young child. He will dutifully observe the contrivances pointed out to him and he will even look out for others ; but he lacks the key to the mystery—he does not realise all that is involved. Food and the care of

offspring are intelligible objects to him ; the production of offspring is obviously not realised with the same distinctness.

In the second place, it is almost impossible for the child to verify by his own observation the blackboard drawings which show the adjustment of the insect's body to the various parts of the corolla-tube. Darwin says : " The primrose is never visited by the large humble bees, and only rarely by the smaller kinds ; hence its fertilisation must depend almost exclusively on moths. . . . It is surprising how rarely insects can be seen during the day visiting the flowers." He supposes, therefore, that they are commonly fertilised by night-flying moths—a supposition which small school-children are certainly not in a position to verify.

As, therefore, this question is difficult, alien to the child's own experience, and from its nature a matter of faith rather than of observation, it is not suited for an elementary course in Nature study, but should be left to the botany course. But in preparation for this it is of great importance to induce a habit of looking at plants and noting their various " ways." Let this peculiarity of the primrose, the varying position of stamen and pistil, be duly noted, and recorded in drawings. Let this observation be a type of many other observations made on flowers that open throughout the summer. Are *their* stamens above or below the pistil ? Are there any instances in which the stigmas or stamens appear to shoot up and occupy a more prominent position after a certain period ? The *discrimination* of forms must precede the rationalised explanation of the differences which they exhibit.

The children will be interested in making comparisons as to the colour of these spring flowers. They are nearly all white or yellow—clear, conspicuous flowers which are easily picked out, even on dull days, by roving insects.

CHAPTER XI

BIRD LIFE IN SPRING

1. *Birds in the Nest. Round the Year with a Robin*

Analogy with human life.—Froebel has noted how the child is helped in his realisation of his own home life by studying the parent and child relationships of animals. His pigeon and chicken games are familiar illustrations of this sentiment of sympathy, and Tennyson's exquisite little song, "What does little Birdie say?" expresses the analogy in words which are as simple as they are tender and beautiful.

Encourage the children to notice any signs of fresh activity on the part of the feathered friends whom they have fed through the winter, and to make records in their bird calendar.

Birds in towns.—Even the town children can see the sparrows collecting bits of straw and odds and ends to make their nests. Sparrows, starlings, and rooks, though they do not trust man as the robin does, yet like to make their nests near his home. There is great excitement among the sparrows—sometimes quarrelling and scuffling. But the surest indication that something is to happen is the song—the twittering of the sparrow, and the varied notes of the starling, for **Bird song in spring.** the starling has many moods, and moreover will imitate the songs of other birds. The sweetest music comes from the blackbirds and thrushes, both friendly enough to nest in suburban

gardens, and both nesting early in March. Browning says that the thrush "sings each song thrice over lest you should think he never could recapture his first fine careless rapture." The song is "Peebur! Peebur! Peebur!" A later observer (Mr. Dewar) points out that the song is hardly "careless," for the bird certainly practises his song, and by May has a clearer note, which is now "Pretty bird, pretty bird, pretty bird!" The general singing of birds is a sure token of nesting-time, an expression of delight in the happy family life that is about to begin, and the bird calendar should note the first time the song of any particular bird is heard.

Town children have confused ideas about birds, which it is worth while clearing up. They are apt to suppose that birds live and sleep in nests all the year round. Tell them that birds sleep or roost in trees, or other sheltered places, standing, with perhaps the head under the wing. The nest is simply a nursery for the young, and is only used as a home while there are young

**Nests and
roosting-
places.**

**The
sparrow's
nest.**

to bring up. Their friends the house-sparrows may often be seen collecting in trees at evening, making a twittering good-night noise. But the nests are in out-of-the-way places, out of the reach of the sparrow's special enemy, the cat. Cats cannot climb up the side of a house or squeeze through a small space, so the sparrow builds in holes in the wall of a house, in water-spouts, under the shallow tunnels that we see in corrugated iron roofing, behind carvings adorning the fronts of houses, and in similar out-of-the-way spots.

Starlings are more adventurous travellers and builders than the sparrow, and will often build in the open country or in cliffs by the seaside.

Wild Birds Preservation Act.—Tell the elder children about the Wild Birds Preservation Act, which provides

a "close time"—that is, a time in which it is a punishable offence to shoot or ensnare wild birds. This time is from March to August. Explain to them that this Act was passed not only for reasons of humanity, but also because nearly all these birds are extremely useful in eating insects which it is impossible to destroy in any other way, and which rob human beings of enormous quantities of food. They can see for themselves how diligent are the starlings, thrushes, and blackbirds in hunting for grubs and other small creatures in the grass. And while the young are in the nests, even birds who are generally vegetarians, such as the sparrow, find it needful to have insect food for their young.

Robbing nests.—Boys should be strongly influenced against taking eggs. They may be brought to see not only the economic reasons, as given above, but also to feel how far more interesting it is, when they discover a nest, to watch it, than to rifle it. If they are careful not to disturb the parent, they can count the eggs, see if the number is added to, watch for the nestlings, note how they are fed by the parent, observe the characteristic calls made by parent and young respectively, and finally have the pleasure of seeing the young complete their education and fly away to begin life on their own account. Once this habit is established, a "nest map," constructed in the same way as was recommended for trees, may quite safely be drawn up for a country school.

The *empty* last year's nest of a hedge-sparrow or robin is still a beautiful object, and if shown to a class, never fails to excite wonder as to how these materials were so laboriously collected and so cunningly woven together by the tool-less little builders; and to arouse this feeling of admiration and respect for dainty workmanship is the best way to inhibit any destructive tendencies.

Nests, in school gardens.—It is quite possible, except in the very heart of cities, to watch some, at least, of the phenomena of nesting in an ordinary school garden. The writer knows of a school within three miles of Charing Cross where thrushes, blackbirds, and robins nested among shrubs, ivy, and low trees, and though the secret was known to the children, and though a tall child of twelve might easily have put a hand into the nest, the birds were able to bring up their broods in peace with no disturbers, except the neighbours' cats.

If the school is prosperous financially, and has anything of a garden, nesting-boxes may be provided to tempt the birds to bring up their families on the spot. From the instance above given, it will be seen that the clamour of children at play will not deter their feathered friends from accepting their hospitality if it happens to suit them. But, of course, the boxes must be placed in situations such as are naturally favoured by the birds themselves. A box suitable for robins measures 6 in. by 6½ in., and has an entrance hole near the top, 1½ in. in diameter. It has a sloping lid, so that the rain can run from the roof. Such a box can be made in the woodwork class of the school. The blue-tit, it must be remembered, likes a box that has an entrance hole of a diameter not larger than that of a penny. A nesting-box must not be startling in colour, but should be painted to harmonise with the colour and texture of the wall or tree trunk against which it is placed.

The device of bird biography.—It must be admitted that it is not easy to observe the nesting habits of birds, as they are naturally shy at this period, and the watcher must not be too close to the nest. Photography accompanied by patience has, however, done much to overcome the inevitable difficulties of this kind of observation, and if the children can be led to watch

part of the process, the teacher may well draw upon the recent material accumulated by the brothers Kearton and others, to make for them an imaginative picture of the whole life of a bird from season to season. Here the device of the biographical story so often used in the Kindergarten may well come in, and the children may be given the history of one of their familiar birds.

The robin as a nest builder.—Though the thrush and the blackbird are much less shy when nesting, it is perhaps better to take the robin as hero of the story, because of its more intimate habits at other times of the year. As we have seen, the robin is most confiding in its relations with human beings throughout the winter, hopping in through the open door or window of an occupied room and picking up crumbs from the carpet, the tablecloth, and the hearth. Out-of-doors it is almost pert in its tameness. The writer has frequently carried on a conversation with a school gardener in which a robin made an apparently critical third, perching on the metal portion of the spade of which the man held the handle. This habit of hopping and flitting near the surface instead of flying brings him nearer to us. But when the time comes for him to make a home, he becomes much more retiring, and will begin, on the other hand, to be very kind and attentive to the hen (whom, by-the-bye, he has neglected all the winter), singing his best song and taking care to place himself so that she has a good view of his orange-red waistcoat. Then comes the building of the nest. - Mr. Granville Sharp remarks, "In spring robins become very reserved and distant. They are very shy about their nests, and, if watched, will drop a bit of

Materials. material and pretend they were only playing with it" ("Birds in my Garden"). The materials they like best are scraps of dry leaves and stalks, moss, and grass. These are moulded into a cup shape and lined with hair or wool, or, failing these, with

delicate little rootlets, by pressure of the breast of the hen bird. Sometimes the hen does all the work. Mr. Kearton tells of one who built a nest in three days, carrying dead leaves and moss to her home five times in five minutes. The cock in this instance did no work, but sang loudly to her all day long to encourage her.

Robins build in all kinds of queer places. A hole in a wall or bank, or in the stump of a tree, is a favourite

**Sites of
nests.**

spot, but Mr. Kearton says: "I have found robins' nests in old tin cans, tea-pots, coffee-pots, kettles, jam-jars, biscuit-boxes, cocoa-nut husks, fragments of bottles, and clock-cases." Those who provide nesting-boxes must not be disappointed if they find that the box is used as a nest for the first brood only; for the second and third broods the pair like to find a fresh spot.

The mother robin lays from four to seven whitish eggs, flecked over with light red spots, and she sits

Eggs.

on them patiently while her mate sings to her from a neighbouring tree. Sometimes he wanders away a little, and then she gives a melancholy hungry call to bring him back. He will often bring her something to eat, some worm or spider or grub, so that she need not leave her charge to seek her own food.

The mother bird sits on her eggs for about twelve or thirteen days, and then the little robins emerge from the

Nestlings.

shell. They do not look like robins; their feathers are short and stumpy, and there is no trace of red upon their breasts, which are brown in colour and spotted like those of a thrush, and, indeed, they do belong to the great thrush family. They are very hungry and withal very helpless; both parents have hard work to find them food. They roam the garden and fields for worms, insects, and juicy berries, which they bring in their beaks and place in the (say) five open

mouths which are gaping and calling for them. This goes on through the whole day until the young are ready to leave their nest; they are still very hungry and still ignorant. They have no idea of doing anything beyond opening their mouths until something is put into them.

Their food and education. The parents have to show them how to eat. Dr. Hodge, in "Nature Study and Life," relates an amusing story, the details of which may be softened by the Kindergarten teacher who relates it to young children. "One of the most interesting lessons I ever saw was given by my big cock robin to his class of four young ones. The task for that morning was evidently to learn how to catch and eat earthworms. It was a drizzling morning in June. All the youngsters were fully fledged, and each appeared almost as large as the daddy. They all hopped along in a group, the parent a little in the lead. Soon he pounced upon a large worm, and while he tugged it out of its burrow, what did the young ones do but sit back, hold their mouths open, flutter their wings, and beg. He threw the worm among them. No one attempted to touch it. He picked it up again, and, whacking it on the ground, broke it to bits. Not one of his class offered to help. They, every one, simply held their mouths open and begged. He tossed the squirming bits on the ground before them. No one caught the idea, and finally he fed a piece of the worm to each one. The same lesson was repeated with the next worm, and the next, and so on for nearly an hour; but never a youngster offered to do anything but sit up and beg. That teacher will remain a model of patience as long as I live."

Foundling nestlings. Dr. Hodge uses this story to show how difficult it is to feed a young bird which has accidentally fallen from the nest. To offer it sops of bread is of no use; it must have the right kind of

food, and this must be put into its mouth. He thinks that children should be advised to put such a bird in a cage covered with green oilcloth, and hang the cage near the nest, so that it may be cared for by its parents.

The robins who nest in woods and thickets have, of course, to meet perils from birds of prey, snakes, &c.

Perils of robin nestlings. It is sad to note that those who choose the neighbourhood of man fare perhaps worse. Mr. Gardiner Butler, in his great work on

British birds, says, "I believe that of the many robins which nest in our gardens and houses, not one pair in twenty has the pleasure of seeing its young leave the nest; nearly the whole of them fall victims to cats." Dr. Hodge deplores the same thing in America. Pussy is in many of its aspects an engaging creature, but there is no doubt that, both on economic and on æsthetic grounds, our insect-eating song-birds contribute far more to our welfare and happiness, at any rate in the country; and it is worth considering whether other domestic pets might not often be substituted with advantage for the ubiquitous cat.

To return to our robins. Though the parents are so careful about the education of their offspring,

Round the year with the parents. these give themselves no further concern once they are able to manage for themselves. Indeed, as we have said, the parents have to bring up a second and even a third brood during the season. When

their last cares are over, the old pair depart in early August to the woods and thickets, where they go through that trying experience or "illness" of bird life—the moulting-time. The thick foliage of the undergrowth gives them shelter, and at this time of year there is plenty of insect food. During the period of the moult, the song of the robin, heard all the year besides, is silent. After the moult his spirits revive, his song is heard

again, and when his food in the open country becomes scarce, he will either, as we have said, choose and fiercely defend against other robins some favourite position near a homestead that he can look upon as his very own; or if he fails in this, he may spend his winter beyond seas—in Egypt, or Syria.

We must just glance at the further history of the young brood. Even when fully fledged they do not at first resemble their parents in plumage.

**The
coming of
age of the
nestlings.**

The feathers, on back and wings and breast alike, show various shades of brown.

They keep this dress until July and August, when they too moult into a second coat of

feathers, with the orange-red of the full-grown robin, though perhaps a little less bright than that of the parents, from whom they may further be distinguished by a yellowish band along the wing, which lasts until next year. With this second coat of feathers comes the power of song, and the young ones call and answer one another in short snatches which will soon become the sweet winter song. Then they, too, even if they have, lived in the woods, will draw near to human haunts, so that in winter the children who have heard this story of its life history can again welcome:—

The bird that man loves best,
The pious bird with scarlet breast,
Our little English robin.

CHAPTER XII

BIRD LIFE IN SPRING

2. *The Story of the Rook*

Bird observations in spring.—We have already spoken of the early nesters—the robin, the thrush, the black-bird. As the weeks go on, the birds who had left us for the winter return, and these also begin their nest-building. Let the children be encouraged to keep a bird calendar or year-book in which are noted arrivals and departures, times of song, nest-building, and flight of nestlings. As the birds who have wintered abroad return, so those who have come to us from the north depart, and migration also takes place from one part of the country to another. Thus the gulls which London children have seen upon the Thames will depart to marshy land and pools near the sea, and lay their eggs among the reeds.

By the aid of a naturalist friend, the local museum, books, and, if possible, a pair of field-glasses, the teacher can make acquaintance with those birds that haunt the district of the school and introduce them by degrees to the elder children.

The rook.—Even the little ones, in whom the power of differentiation is slight, can be interested in rooks and rookeries. The bird itself is quite common, and is striking by reason of its size, its glossy black plumage with purple shades, and its characteristic "Caw, caw!" Notice the long stout beak specially adapted for digging

after grubs, and not unlike a pickaxe in appearance. Compare it with the broader beak of the sparrow and the various finches, who feed upon grain. The long stout beak of the rook has constantly to be thrust into the ground to dig out worms, insects, and grubs, for which work a short broad beak would not be a suitable tool.

Rooks and crows.—Children sometimes ask how to tell a rook from a crow. This is not easy by mere inspection from a distance, but they may be told to note that a rook, if it happens to be a full-grown one, has bare unfeathered cheeks, while a crow has feathers all over the face. Young rooks have feathers on the face at first, but these are moulted when they come of age. Moreover, rooks are generally seen in bands, and crows only in pairs.

Rooks : their life in common.—The habits of the rook are easily noted even by young observers. First of all, their way of living in companies seems quaint. But we know very little as to how they manage their communities. We are far more familiar with the social arrangements of the bee and the ant than of these citizens of the air and the high trees. They will

Discussions. assemble together in large flocks in the meadows and hold serious meetings for some purpose which we cannot guess, though from the clamour we know that the matters under discussion must be of serious importance. During the day they are busy in the fields, where in spring they march

Feeding. behind the farmer, pouncing on the worms and grubs that are turned up by his plough from the fresh soil, or exploring the fields on their own account. One of their number is posted as sentry to give an alarm in the case of danger. Their food is varied—snails, worms, and larvæ of various insects, which are dislodged and picked up by the

sharp bill, are their favourite meals, but when the ground is dry in summer they will eat mice, young birds, and eggs. At harvest time they are diligent gleaners, and during the autumn they consume fruits, beechnuts, acorns, and berries. They are guilty, it must be owned, of stealing grain that is still ripening for human food, and of tearing up young seedlings of turnips. In the bad old days before the law provided that all children should go to school, little boys of seven and upwards were often paid a few pence a week for spending their days in the fields scaring rooks. Rooks, like many other wild things, have a bad name which they do not deserve; for, in spite of the mischief they do by eating seedlings, and fruit, and the eggs of partridges and pheasants, they also eat quantities of insects that would otherwise devour far more than they take as their own share, and hence they must be looked on as the farmer's friends.

They not only discuss business and dine together, but among the high houses of Rook Town, when nest-building is in progress, they are said to hold courts of justice, and offenders are expelled and sometimes even killed.

All this is hard work, but some of their meetings are for recreation. When evening comes, as Gilbert White noted long ago, they meet together in the upper air, wheeling and diving in a manner that can only mean play, their caws blending together in a confused but not displeasing noise. This is evidently a joint exercise for relaxation—a sort of frolic before bedtime. The procession across the evening sky to their roosting-places, with the cawing accompaniment, finishes the day.

Nest-building.—Rooks are often badly treated by men, but, in spite of the shooting of their young in summer for rook-pies, they persist in making their

nurseries near human habitations. They like to build in elm-trees, and the chosen trees are nearly always near a house, in a park, or in an open space in a town. They begin to build early—at the end of February, before the leaves are on the trees. Thus we can easily watch the process. The “building rooks will caw from the windy tall elm-tree,” and there is more cawing than usual; for, though they carry out their sociable instincts in liking to form colonies, they are often guilty of stealing materials from one another, and there is much clamour, many quarrels, and sometimes an expulsion. But once the nests are made, every pair settles down to its own business, and the rookery is at peace for a time.

The high nests rock in the March winds, and sometimes accidents happen, but not so often as we should suppose, for the lattice-like sides of the nests are built up round a good solid platform. Unlike the robin, who, as we saw, makes a new nest for each brood, rooks seem to cling to their old nest, and will often repair it instead of making a fresh one; hence the somewhat untidy appearance, as of a frayed wicker-basket, of the nest as seen from below.

Mr. Phil Robinson, in a pleasant book called “In Garden, Orchard, and Spinney,” gives a charming sketch of some nesting rooks whom he had closely watched from his windows, and many of his observations might be utilised as story material for little ones. He describes how diligently the father bird fed the mother bird while she was sitting (rooks are specially kind and faithful in their family relations); how he called to her “Core, core!” and she replied “Car, car!” Mr. Robinson made out some other elements of rook language. When a passer-by rook saluted the sitting mother, she would say “Quah!” When she was talking quite

quietly and confidentially to her mate in the nest she would say "Cul-cul-cul!" "like the sound of water bubbling in a hurry out of a small-necked bottle," and when she settled down comfortably over her eggs she would utter a pretty liquid note, "Killoop!"

The father was an early riser, starting off before sunrise. He spent nearly the whole of the day in hunting for food, and in bringing it to the nest. Even when resting, he would have his responsibilities on his mind, for he would keep near the nest, looking out for suspected assailants. "The hen has found out," says Mr. Robinson in his notes, "that he need not always be taken very seriously. Perhaps he will espy a labourer crossing the field, and he is up at once, shouting, 'Fire! Thieves! Murder! Help!' The hen slips quietly off the nest, joining him where he is wheeling above the tree-tops and crying 'Begone! Be off! . . .'" to the assassin his uncommon vigilance has discovered, and on seeing the inadequate cause of his immoderate conduct, she remarks drily, 'That's all!' and returns to her eggs." Twice a day, at least, the father would bid the mother take a little flight to stretch her wings; and he would stand guard over the eggs, not sitting on them, but "minding" them until she came back. When the eggs were hatched, the young rooks were fed for the first six days by the mother alone. She would prepare in her own mouth the food brought by the father. After the first week the young were able to take their food without this previous cooking, and then both mother and father went off to seek food, and the father helped to feed them on their return. But the little ones had been so used to receive food from their mother that the father was almost a stranger, and they received him and his good things in silence, though they clamoured with joy at the sight of their mother,

even when she had nothing in her beak. This, one thinks, was rather hard upon papa.

Sometimes, while the old birds were searching for food, they would be aware of a strange bird settling near their home. Immediately they

Defence. would rush to the rescue, but not both together; one would dart upward from the meadow and dash through the boughs, and another descend steeply from the upper air, so that the intruder would find himself caught between the two.

When the fledglings are ready to fly, they have to be educated, as were the young robins. Mr. Gardiner

Education. Butler ("British Birds") says: "When the young first leave the nest they are awkward and weak on their legs, sitting huddled on a branch with their heads well down between their shoulders; as the wind sways the branch, they tip forwards and have to open their short wings to recover their balance; but after daily short excursions from branch to branch, they gradually gather strength and confidence until they are able to accompany their parents to the fields and get their first lesson in finding food for themselves."

Mr. Robinson gives us details of a lesson of this kind: "The father was making for a poplar on the other side of the meadow, about two hundred yards away, and the young bird, flapping vigorously but irregularly, was following bravely. But the distance was too great, and just as the father reached the tree and curved upwards in his flight to settle on it, his offspring gave up the struggle, and slanted down, with outstretched wings still beating, into the tall grass. And for hours afterwards the parents were calling to the youngster to get up and try again. That he did so eventually and succeeded I know, for I saw all three young rooks next day perched in a row upon the poplar."

The autumn and winter are spent not in the rookery,

but in thicker and more secluded woodlands. But, unlike many other birds, rooks seem to take an interest in their deserted nurseries, and frequently come to look at them. Gilbert White describes a flock who would call at their rookery every evening in the winter on their way to their roosting-places in the deep woods and return to sit at dawn on the same nest-trees.

Round the year with the rook.

The rook is a long-lived bird, and for many springs it will return in February or March to the old rookery, to repair an old nest or build a new one. Some of the younger members of the community add to the colony, but, as we have said, the forming of new nests is by no means a peaceable matter. Some are hindered from building until the nests which have been started are completed. Others are forbidden to build at all, and must fly away to start a fresh rookery elsewhere.

Method: defence of the story device.—In taking the children through the cycle of the year with the rook or robin, we are, of course, obliged to abandon the method of pure observation. The children cannot see for themselves what is described to them. This need not be alarming to the conscientious teacher who has been trained to realise the importance of "self-activity" in the young and to consider that this self-activity can only be utilised through the "heuristic" method. For a little reflection will show that many of the observations made throughout life by children or by adults are merely glimpses of phenomena, frayings from a mighty web. We see "odds and ends" of Nature's ways with plant or beast, and not the whole. To follow for ourselves the clues thus dropped would demand the leisure of a lifetime. In practical life we do not pursue this method, nor are we content with ignorance. We observe something, and our self-activity is then

Observations need interpretation.

involved in seeking *interpretations* of what we have observed. We catch a hint of the pattern, and we seek for aid to make it out from those who have been studying this particular part of the tissue of knowledge, and can be trusted to trace it accurately. One of the aims of education, indeed, is to show how fragmentary our knowledge must be, and how lovers of knowledge in any branch are in debt to those who have had the

**Obligation
to original
observers.**

time and opportunity to weave these fragments into one intelligible story by continuous and patient watching. In using the material thus provided for us, we are simply applying to animal life that imaginative treatment which, when applied to human nature, makes biography and history. The appearance of the creature gives some hint of its ways, and the information fulfils a natural desire to form a picture of its home life and of its doings when out of sight. Children ask with regard to any moving thing one invariable question: What is it *doing*? They like to know the *business* of animals. This business has been well summarised as consisting of two principal lines of work: (1) Care for themselves, including (a) the finding and securing of food; (b) self-protection; (c) adjustment to physical surroundings. (2) Care for offspring. To give information supplying this kind of knowledge is to satisfy interests which are perfectly wholesome and to satisfy the child's desire to know, as he would want to know of a human hero, "how the story ends." And it is no small service to children

**The
literature
of Nature.**

so to interest them in stories of Nature as to give them, in after-years, a taste for that growing literature of Nature which is such an interesting feature of our time, and which may well claim a share of the study at present given by young people to the football score or the novelette.

CHAPTER XIII

SEEDS AND SEEDLINGS

1. *Seeds and Seedlings Grown for Observation*

SEEDS may be sown, for observation, in the winter or quite early spring. But it is disappointing to the children if they are spoiled by a frost in the cold school-room during the night, though an occasional accident of this kind is instructive. They will come on much faster if the planting is left until the right season is upon us. Then we may plant for two distinct purposes:—For observation of *methods* of growth, and for the sake of a *perfected* growth of plants sown for use or for beauty.

The seeds grown for the sake of observing their behaviour in germinating should be planted where they can be easily observed, in pots of damp sawdust and cocoa-nut fibre as well as in mould, and in glass vessels through which the roots can be observed. Small seeds can also be grown on sponge, or flannel, or damp blotting-paper, or bath brick, care being taken to keep the surfaces moist.

Examination of seeds—external characters.—Before planting, let the class examine the seeds themselves sufficiently to enable them to carry in their minds a picture of the *whole* history of the structure that is to unfold before them. A collection of seed-vessels, with the seed in them, is the work of an autumn term, but the connection of the seed with its containing

case must be brought to mind in the spring. The children will see that the seed is quite *unlike* the parent plant in appearance; it seems to have a character of its own. This gives good practice in identification, and the collecting instinct may be used in gathering and naming seeds. The quaint little black seed of the onion, the bordered seed of the vegetable marrow, the yellow seed of the mustard, the darker brown of the cress, the black with white stripes of the sunflower seed, the mottled and crested seed of the castor-oil plant, looking curiously like a beetle, the three-cornered seed of the beech—are all as interesting in their way as the flower and the leaf. But since children are naturally more interested in what a plant *does* than in what it looks like, this examination must not become a mere exercise in the discrimination of form and colour, but must be used as a start in a *series* of observations on the life history of the plant. Let them consider

The protection of the seed.

the plight of the seed, cast off from the parent plant to begin life entirely by itself. Upon it is laid the responsibility of producing a fresh plant with all the organs of the parent. Does the parent give it any help? A study in fruits in autumn will bring to light some of the more obvious cases in which the parent provides, by means of the seed-vessel, protection, and often, in addition, means of locomotion. But the seeds themselves have tough coats, as may easily be seen in the case of the broad-bean. What is there within that is to be thus protected, and how will it break through such a covering? Let the seed be looked at, drawn, coloured, named, and then planted in view of the class. Let the children watch a large seed like the pea or broad-bean daily. Perhaps the most practicable method, and that which pleases children most, is to have them near the glass sides of a tumbler or straight

lamp-glass filled with moss, which must be kept damp. Plant a good number of seeds at intervals of four or five days, placing the later ones in mould so that they may be left to finish their career after the earlier ones have been taken up for observation. The younger children should observe through the glass, the elder ones, who have learnt to temper curiosity with respect for livingness, may take out the seedlings at different stages and find out what they are doing. The important thing is that the children shall recognise the plants to have initiative, selective power of their own, behaving differently after their kind—in other words, to be *alive*.

The seed before germination.—In order to interpret what they will afterwards see, these children may examine the soaked seeds of a broad-bean. The toughness of the coat is evidently for protection of what is inside. The scar marks the place at which the bean was attached to the pod which contained it. (A model in stiff paper of a bean and a pea pod, made when the fruits were ripe in the previous season, is very useful at this stage, though the real ones keep very well.) Let the children squeeze the bean until water exudes from the "little gate" or "root-hole," as we may call the micropyle. Where is this hole? Let them now remove the tough coat and see how easily two broad fleshy bodies contained within can be parted asunder, and how between them lies a little curved structure with a tuft or bud—the future stem, to which the big fleshy bodies are attached, and also a downward peg-like portion which is not tufted at the tip, and which is the beginning of the root. This little curved structure between the big fleshy bodies may be called the "baby plant," and its careful protection on the part of the mother plant is shown by its position. Having thus studied the seed, the children may now look for the

The seedling.

seedling—i.e. the growing plant which the seed produces. The sign that the seed within is really alive, and is about to produce its seedling, is the bursting of the tough outer coat. Watching their seed, the children will see the radicle, or future root, coming out first. Let them

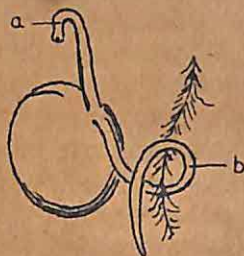


FIG. 14.—PEA

a. Stem. b. Root that has curved round an obstacle—a bit of moss.

watch, through the glass, how the radicle tends downward, how it avoids the light, and how it winds round any obstacle such as a bit of card or a stone that is put in its way. It behaves as though it were a tiny sensitive finger. The question may be asked them, which is put by Ganong in "The Teaching Botanist": "How does the young plant know which is up, which is down, whether there is darkness below, or moisture, or something else?" It will be salutary for the children to realise that this is a question which cannot be answered. Little experiments may be made to show the persistent downward tendency of the roots. Place a seedling which

Simple experiments on roots.

has been growing downwards in a normal way in a lamp-glass, bottle, or tumbler, into a horizontal position, so that the roots no longer point downwards but lie parallel with the table along which the vessel is lying. Let the class notice how the roots nevertheless immediately start a downward course, curving over towards the side of the vessel which rests on the table. Turn one or two

seeds upside down and let them notice how the roots will have their own way and bend over, travelling down by the side of the seed towards the bottom of the vessel. But the tendency to travel *downwards*, strong as it is, is not so strong as the craving for *moisture*. If seeds are grown on a piece of coarse muslin or netting kept moist, the roots will at first find their way *downwards* through themeshes. But on finding no moisture, they will turn backwards and upwards, seeking once more the moisture which is needful for them.

Growth and branching of the root.—The root grows to a considerable length before the stem appears, because it has to absorb the moisture necessary to nourish the young plant and the leaves that it is soon to bear. It continues for some time to grow at a greater rate than the stem. When the little root is about an inch long, the seedling should be taken out and held against a dark surface in a good light. Fluffy hairs will be seen growing thickly behind the tip of the root. These are the *root-hairs*, and the children may be told that their work is to suck up into the plant the moisture which they find in the soil. Cress seedlings grown on moist blotting paper in a warm place show these root-hairs wonderfully well.

By-and-by the root gives off branches, whitish in colour like the parent root, and much stouter than the root-hairs. They behave as did the parent root, feeling their way through the soil and holding the plant firmly down in the ground, but stretching sideways rather than downwards.

The infant stem, or plumule, makes a little arch, or "crooks an elbow" as it comes out, and it must be noticed that in the broad-bean the arch is *above* the point where the seed-leaves join it, so that it does not draw the seed-leaves up with it. The arching is to protect the little bud at

the end of the stem, which might be injured as it works through the soil. When the bud is safely withdrawn, the stem straightens, growing upwards, and the little tuft opens out into green leaves.

The children will see that it was the tiny curved thing lying in the hollow of one seed-leaf and covered by the other which was the important part of the seed. The protecting coat falls away and the fleshy

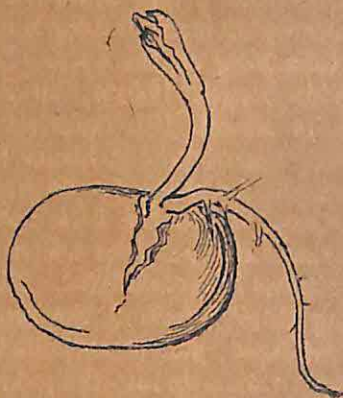


FIG. 15. — BEAN

seed-leaves become flabby and finally disappear, but the baby plant lives and grows.

The children will know that leaves are used for food, as were also the scale-leaves of the onion bulb. The

The seed a storehouse.

question: "What provision did the parent plant make for the seed, besides giving it a protecting coat?" may now be answered by comparison with this previous bit of knowledge. The bean seed had nourishment packed away in these fleshy bodies, and thus the seedling had a start in life, existing for a time on the stores provided for it.

The future success of the seedling will depend upon the food it can make for itself. This food, as explained

in a previous lesson, is derived from the soil and from the air, and is worked up by the plant in its green leaves.

The future
growth
of the
seedling.

Our bean seedling must be given a chance of thus making its living. The fleshy bodies within the seed were "makeshift" leaves or "seed-leaves"; it must now depend on its true leaves or "proper" leaves as they have been called. The seedlings grown in sawdust or moss will not^o be able to live long; those intended to survive must be planted in good soil. Moreover, the green leaves must have light, for only in sunlight can they turn the material taken from the air and from the soil into foodstuffs for the plant. Let the children notice the growth of a bean placed in a pot with mould in a dark cupboard. They will see how weedy and poor is the plant produced, how yellow and small are the leaves, and how they are not spread out flat. They will notice how the stem is turned to the chink of the door, as though begging for the light denied to it. A similar lesson, though not quite so marked, may be learned by growing plants on a table removed from a window, and then placing them in direct light. In three or four days a difference will be noticed in the size and colour of the leaves. The teacher will not fail to draw the moral of the value of sunlight for children also, and thus contribute a little towards breaking down the folly of denying the entrance of sunlight into human homes because of considerations as to upholstery and furniture.

The bean seed, because of its size, is nearly always the seed used to show the process of germination, but the teacher should have other large seeds, such as the acorn, date, almond, filbert, horse-chestnut, and walnut seeds, germinating at the same time in order to show the variety of Nature's methods, especially in the time of "rest" necessary in the case of different seeds before germination

is possible. It is specially important, too, that the children should note that not all seed-leaves behave like those of the bean—*i.e.* remain within the coat and dwindle away as their stores are consumed. This

The subterranean seed-leaves not typical.

subterranean method is, indeed, the exception and not the rule. In the case of the kidney bean, the arch of the plumule is *below* the seed-leaves, and these are freed from the coat and come *above* the soil, and this is the usual case. The soil clings to the coat and holds it fast while the plumule works upwards and



FIG. 16.—HONESTY

a.—Stem which has carried up the seed-leaves *c*.
b.—Root with root-hairs.
d.—Seed-coat slipping off.

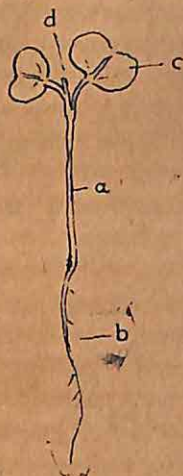


FIG. 17.—MUSTARD

a.—Stem with seed-leaves carried up.
b.—Root with root-hairs.
c.—Seed-leaves kidney shaped and one larger than the other.
d.—Undeveloped stem.



FIG. 18.—CRESS

draws the seed-leaves with it, leaving the coat, like an empty glove, behind it. The vegetable marrow puts forth a little peg from the young stem and holds the coat firmly in the ground, while the leaves grow out

of it. The coat of the cress becomes sticky after the seed is planted, and so is glued to the ground, as it were, thus helping the seed-leaves to escape. The coat of the "honesty" seed does not slip off until the seed-leaves are above ground. On reaching the open air, the seed-leaves generally become green and start work like true leaves, building up food for the plant. In mustard and in cress, the true leaves are not as a rule allowed to develop; we eat the transformed seed-leaves as salad. Let the children note that the mustard seed-leaves are kidney-shaped and one larger than the other, while in the cress each seed-leaf has three lobes; and this may lead to watching the seed-leaves of other plants and noting their shape. If

Shapes of opportunity is found of watching seedlings
aërial seed- where they grow or of rearing them in
leaves. the garden or in pots, it will be found not
 only that seed-leaves differ in form, but

that they are often curiously unlike the true leaves of the same plant. Thus, the sycamore has very broad foliage leaves, but the seed-leaves are long and narrow. Those of the beech are easily recognised by being folded up into the shape of a thick hand-screen, while in the foliage leaves can be seen the platings of a fan. The pink and laburnum, whose true leaves or leaflets are long and narrow, have very broad seed-leaves, and those of the wallflower are like two little clubs.

Germination of a plant with one seed-leaf.—After the pupils have become used to detecting the presence of *two* makeshift leaves, germinating wheat seeds may be examined. The elder children will be able to find that the mass of nourishment in a wheat seed is not packed away into a leaf store, but fills a large part of the cavity of the seed-coat. The little plant lies within a tiny fold or shield. This fold (the scutellum) is sometimes spoken of in botany books as if it were a

separate structure, but it is really the lower part of the *one* seed-leaf which the seed contains. When germination takes place, the roots first appear, and then a sheath or envelope pointing upwards. This is the upper part of the seed-leaf, and within it is a bright green rod, the young stem and its foliage leaves, which will afterwards become the long narrow blades we know. In this case the young plant is nourished, not by the



FIG. 19.—WHEAT

- a.*—Young stem enclosed in sheath (seed-leaf).
b.—Roots (3).
c.—Separate store of food.

seed-leaf itself, but by the separate store in the seed. The lower fold of the seed-leaf sucks it up and conveys it to the growing plant. When all the food has gone the seed-leaf perishes, and only the empty husk of the seed remains, but by this time the young plant has its own new leaves, and can manage for itself. The children will notice that the root of the wheat, instead of forming one main axis as in the case of the bean, breaks up at

once into fibres, which lay hold, as it were, on the soil, and attach the plant firmly to it.

Classification of plants based on number of seed-leaves.—Germinate maize and barley in the same way as wheat, and then let the children make their comparisons with the seedlings of peas and beans. They will notice the parallel veins of the plants that had one seed-leaf and the netted veins of the others. Then set them to watch for other instances of leaves of each kind, and ask them also to notice how many parts they can find in the flowers of each kind. The plants with one seed-leaf produce flowers whose circles show threes and sixes in the number of parts they contain, while those with two seed-leaves show, as a rule, two, four, or five parts in each floral circle, or sometimes multiples of these numbers. This will form the beginnings of the classification of flowering plants into monocotyledons and dicotyledons. The names can be given to elder children as a substitute for the rather cumbrous though clearer description they have before used.

It is unnecessary to advise that drawings should be made of the seeds, and of the seedlings in all stages. Let the children use lettering freely to indicate the parts and describe in their own words what they see.

CHAPTER XIV

SEEDS AND SEEDLINGS

2. Conditions for a Seed to Become a Seedling

THE children may now be set to answer the question:—
 What are the conditions necessary in order that the seed may become a seedling, and then grow up to be a mature plant? The heads of their answer will supply them with principles to be applied in the culture of plants in pots or garden beds. First of all, they will find that seeds of different plants will not germinate in the same time; each seed must have a period of "rest" after leaving the parent; this means that certain chemical changes take place within it.

A period of "rest." Again, the seeds that thrive under the care of Nature out in the open are generally those that have been buried so as to be protected from the rotting action of the winter rains, but not so deeply

Air as to be deprived of air. If we take two sets of seeds ready to germinate, and place one set in a stoppered bottle and the other in a bottle with moist air, the latter will germinate and the former will not. We take this hint from Nature when we are planting seeds in a pot. The homely red pots used are porous, and some air is supplied through the sides.

Moreover, we must not bury the seeds too deeply, though the depth should not be less than their own diameter, and the general rule for seeds like the bean would be from $1\frac{1}{2}$ to 2 inches. This allows access of air

from the loose soil immediately above them. If we plant in flower-pots or flower-boxes, we get from the florist or from a gardener fine soil that has been properly prepared to ensure that it is porous enough to let the air come through.

If we are to plant in a garden, we dig the ground over, and afterwards break up the clods. The earth-

Tillage. worm turns up the soil for us, so as to make

an infinite number of tiny channels along which air as well as water can penetrate. Let the children see, as at Stepney Borough Museum, a large glass jar partly filled with a deep layer of earth, and above that a layer of sand. A red band round the outside of the glass marks the junction of the two layers. They will see how half a dozen earth-worms, introduced into the jar, will turn over the soil so that the two layers completely intermingle. This prepares them to realise in some measure the enormous amount of tillage carried on by these little creatures. The farmer does this on a large scale when he ploughs and harrows the field. Besides

Temperature. air, a certain temperature is necessary. When the seeds are sufficiently ripe and the ground prepared, they wait until the right

amount of heat reaches them, and then respond in the wonderful way we have noted in our observations in the schoolroom. The temperature varies according to the kind of seed; thus the date requires a far higher temperature than the bean. Wheat will germinate at a temperature a little above freezing-point; this is why we can see the green blades of the wheat piercing the soil in winter time. The amount of heat needed depends on the native home of the plant. The flowers that are sold in the streets in January and February come from regions such as the Riviera, where the spring warmth arrives earlier than with us. Our greenhouses and the "sub-tropical" gardens or sheltered sunny

spots in such places as Kew Gardens or Battersea Park are attempts to make certain plants from a warm climate feel "at home" by giving them somewhat the same temperature they would have in their native home. But a certain amount of warmth is necessary for all plants, and when this comes to us by reason of longer days and sunbeams that have less slant (here refer to the observations suggested in Chapter V.), the seedlings "spring," as it were, out of the ground in response, and give a name to the whole season. Early seedlings that have been destroyed by frost yield an instructive comparison. Try to help the children to realise the relatively enormous *force* exercised by these springing seedlings on the earth's crust as they push upward through it. Show the well-known experiment of filling a bottle, or preferably a Florence flask, quite full of soaked peas ready to germinate, corking it, and then letting the children observe that the bottle is burst by the living things within. This will not be necessary in stony districts, where seedlings can be seen pushing their way between chinks in a rock.

Moisture.—Another necessary condition is moisture. The seeds grown for observation were seen to swell. This was because they had absorbed water, which was necessary, indeed, to dissolve the nourishment packed away within the seed-coat, so that it might travel to the growing parts of the plant. If by chance the sawdust became dry, the schoolroom seedlings perished. But if the moisture be excessive, the seeds will rot; and this also may be shown by covering seeds with water. The three necessary conditions for germination, besides a ripe seed, are, therefore, air, moisture, and warmth.

Need of food from the soil.—The seedlings grown in sawdust or cocoa-nut fibre soon perished; there was not enough food for the roots. If our seedling is to become

a full-grown plant, it must have food from the soil, as well as from the air. What is the nature of this food? It is impossible to explain this satisfactorily to children under twelve; but, on the other hand, it is important that they should understand how much depends upon soil. In order to bring this out, perhaps a little feat of jugglery, as they will think it, may be permitted. The teacher may prepare, in the presence of the class, two beakers or tumblers full of water or clean sand, to one of which the ingredients of a culture solution are added. The ingredients may be obtained in a powder from a chemist for twopence.* A sunflower or wallflower seedling may be inserted in each tumbler and held in position by means of a slit card fitted over the top. One will thrive, the other will soon perish. The thriving plant is the one in the vessel to which the powder was added. Tell the children that the soil of our fields and gardens contains the same substances as were in the powder, sometimes more, sometimes less of these ingredients. The water in the spaces between the particles of soil dissolves them, as did the water in the tumbler, and the root-hairs (cf. experiment with cress grown on moist blotting-paper) will absorb them for the plant. When we see people putting manure upon the soil, this is because the manure gives some or all of the substances contained in the powder. Gardeners raise a heap whereon they throw dead leaves, stalks, grass cuttings, &c.; they cover it with a layer of earth so as to prevent the evil smell penetrating to the air. (Here it is useful to dwell upon the *disinfecting* properties of the good, cleanly, wholesome earth in connection with the disposal of refuse.) When the compost, as it is called, has decayed, it makes an excellent dressing,

* Litre of water; potassium nitrate, 1 gram; sodium chloride (common salt), $\frac{1}{2}$ gram; magnesium sulphate, $\frac{1}{2}$ gram; calcium phosphate, $\frac{1}{2}$ gram; calcium sulphate, $\frac{1}{2}$ gram.

though we ought rather to say "food," for the garden. If one has a garden, it is better to put all vegetable refuse on this compost heap, and not to burn it first as some people do. The mould which we buy at the florists for our pots is partly composed of vegetable mould which has been obtained in this way.

Preparation of soil for pot culture.—The soil for pots must be sifted to remove stones, for besides the fact that these contain no nutriment, and yet take up space, the observation of the experiment on the root of the pea making circuits to avoid a bit of moss or card will show us that the presence of stones causes wasteful efforts on the part of the roots (*vide* p. 96).

The bottom of an ordinary red flower-pot has a hole in it. Why is this? Remember the seeds that rotted

Drainage. through too much moisture in their saw-dust. These holes are to allow the surplus

moisture to run away, and the better to prevent the soil becoming a little swamp at the bottom, we place above the hole layers of stones rejected from the upper portion or bits of broken flower-pot. The porous sides of the flower-pot also help in getting rid of superfluous moisture as well as admitting air. Young plants are often "brought on" in very small pots—"thumb" pots—because this size ensures that the roots within shall be at no great distance from the air in any direction, and also they are better able to get rid of moisture that is not wanted. Compare the growth of a seedling in a "thumb" pot with one planted in a tea-cup of the same size; but having, of course, glazed sides and no hole in the bottom.

Preparation of garden beds.—We can apply the same principles to the garden. Here digging is necessary to loosen the soil into clods. The sun and wind and frost help to break up these clods into a more powdery condition. Soils differ in the ease with which they yield

to this breaking-up action. Clay, when turned over, persists in forming moist slabs which are very stiff and unyielding, so we put lime upon it to make it lighter—i.e., to break it up more easily. Sandy soil is light, but there is not much nourishment in it. The rich black mould which we see in well-kept gardens is composed mainly of decayed leaves and other organic refuse which is very nourishing to plants. Plants, however, show their individuality by liking different kinds of soil, and this must be taken account of in choosing them for planting, or in preparing the ground. In the course of rambles or holidays the children may be led to compare the plants they find growing on a sandy common, on a chalk down, or in meadows by a river-side. By-and-by this may lead to the formation of a rock garden, a bog garden, &c.,

Weeding. where natural conditions of soil and moisture are imitated on a miniature scale. Very probably weeding will be necessary. The children may be taught to look upon weeds as plants which, though interesting in their way, persist in growing in places where they are not wanted. They take up the moisture and other food in the soil which is wanted by the cultivated plants, and they grow so fast that they over-top these, and rob them of the light and air which are necessary for their green leaves. Hence gardeners dislike them in the tilled beds, though they are to be studied and admired in the hedgerow or on the common. And some weeds may be transplanted to the "wildling" portion of the garden and watched there, though care must be taken that the blossoms of freely-seeding ones are gathered before they are ready to scatter their seeds; and those that have creeping roots or root-stocks must be quite away from the cultivated beds.

Drainage.—The same need for drainage occurs in a garden as in a flower-pot. So we must see that the

treatment needed by each kind. The object may be no higher, at first, than the exhibition of the grown specimens at the school flower show (surely one of the most innocent forms of competition); but the care and attention involved have a very powerful though subtle educative effect on the cultivator. Froebel says, in his "Education of Man": "If the boy cannot have the care of a little garden of his own, he should at least have the care of a few plants in boxes or pots, filled not with rare and delicate or double plants; but with common plants that have an abundance of leaves and blossoms, and thrive easily. The child or boy who has guarded and cared for another living thing, although it be of a lower order, will be led more easily to guard and foster his own life."

CHAPTER XV

TREES IN APRIL

Catkins and Buds

As soon as April opens, the teacher, if he has not done so before, should begin to take the children out of doors for a few minutes each day, or at least once a week, always with some definite purpose in view. Except, perhaps, in a hopelessly urban district where not even a public garden is available, some new surprise of Nature is always to be seen if only the right suggestion has been applied to the brains behind the young eyes. In April, the children may be asked to look for *flowers that grow on trees*.

Trees bear flowers.—That trees do bear flowers is by no means a matter of common knowledge even to adults. The following is the report of a conversation overheard on a coach:—"A lady and three gentlemen, obviously cultivated people, passed some willows in flower. Said the lady: 'What are those?' Said the first gentleman: 'I don't know.' Neither did the second gentleman. 'The local name is palm,' said the third gentleman; 'I don't know their proper name.' 'But,' said the lady, 'what do they turn into?' Third gentleman, who was the best informed: 'Oh, they turn into trees; very nice trees.' Lady: 'But have they any leaves?' Third gentleman: 'Yes, nice green leaves.' Lady: 'The children say they were told at school the other day that all trees have some kind of flower; is that true?' Third

gentleman: 'Well. You might suppose so, but of course it isn't so.' Lady: 'Oh, I thought they couldn't have understood what they were told. I shall tell them what you said.' " A sense of humour, which consists in a recognition of incongruity combined with a sense of superiority in which the element of spite is absent, is a very valuable quality, the cultivation of which should not be neglected by the teacher. He may therefore tell the story to the twelve-year-old children after he has helped to the fuller knowledge which will enable them to appreciate the point of it.

Why the flowers of trees are overlooked.—The misconception is partly due to the fact that most trees bear their flowers at an early period when few people are out of doors engaged in Nature study. Also, the flowers themselves, being mostly wind-fertilised, are therefore inconspicuous, and moreover they are borne high up on the tree. But in country districts the trees observed since January will probably include those whose flowers are fairly visible; if not the alder and the birch, yet almost certainly the hazel and the willow.

The two latter trees can be made interesting even to town children, for all children are nut-eaters, and boxes of hazel catkins are easily sent from the country, while the "palms" of willow are sold in the streets of towns just before Palm Sunday.

The flowers of the hazel.—To begin with the hazel, which is a low-growing tree often seen in hedges. In the autumn we may note in addition to the ordinary "resting" buds, little dark, hard bodies like stiff, scaly tassels, but upstanding instead of hanging down. In February these tassels have altered both their position and their colour; they now hang downwards and have become a greenish-yellow colour, afterwards turning to primrose. Also the scales have become loosened, and each is seen to be somewhat triangular in

shape, and to form a shield or hood under which little stamens are fastened. The tassel is, in fact, a collection of pollen-bearing flowers, and the overhanging shield or bract takes the place of the circle of coloured leaves that we saw in the hyacinth and celandine. A quantity of dry golden dust—the pollen—is shaken from the tassel, when ripe, by every puff of wind. Give the name "catkin," a favourite word with children, especially if they are reminded that it means "little cat," "kitten,"

Pollen-bearing flowers.

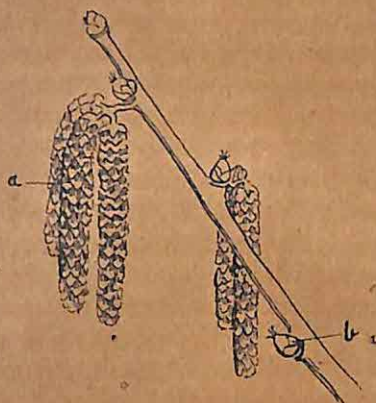


FIG. 20.—HAZEL

a.—Pollen-bearing (staminate) catkins.
b.—Pistillate flowers with crimson stigmas.

and can recognise the appropriateness of the name by the soft "feel" of the tassel. (The term "catkin" should be limited to the long and generally pendulous flowers of one sex, that fall off after their work is done.)

It appears that there is no seed-vessel in the tassel. Where, then, are the seeds produced? On the same branch with the catkin will be found, as we have said, tiny buds. But by March certain of these buds, not at first distinguishable from ordinary leaf buds, will show a tuft of crimson styles hanging out at their

summit. These are to be the seed-bearing flowers. The children have been told that in order that plants

Seed-forming flowers. may produce fresh seed, pollen must be received into the seed-vessel. Here the seed-vessel is somewhat removed from the pollen. How does it reach the

crimson stigmas which are waiting for it? A gentle shake, or even a movement of the breath, will show that the hazel depends on the wind. Some of the

Pollen borne by wind. dry loose pollen must certainly fall on the stigmas, from which it will reach the seed-vessel below. The children can see the advantage of these flowers appearing

before the leaves, which would form innumerable screens catching the pollen on their broad, rather coarse blades, where it would be wasted.

Nut-clusters.—It may be noticed how, though the little crimson-tipped cone which is to form the seeds is found quite close to the branch, where it gains some protection during the winter, yet by September we find instead a cluster of nuts standing quite away from the parent branch. The crimson-tipped "bud" is really a "head" of flowers, and when the stimulus of the pollen has been received, branching takes place within, and the stalks which are to bear the nuts lengthen out, while leaves are formed on the same shoot. The cup of bracts which surrounds each nut is also leafy, and changes colour from green to brown like the ordinary leaves.

Willow catkins.—It will now be interesting to compare the hazel with the "pussy willows" or palms. In the first place we find that the pollen-bearing and seed-bearing flowers are even more widely separated than they were in the hazel, for they grow on different trees. The staminate flowers are specially soft and "pussy"-like in March, when they are of a silvery-grey colour and enclosed in bracts of a rich brown

colour, which afterwards fall off. By-and-by the silvery colour gives place to golden, as the yellow-tipped stamens lengthen beyond the dense covering of grey hairs which protected them in their early stages.



FIG. 21.—WILLOW
Staminate flowers in March

The seed-bearing flowers of the willow grow on another tree. Each little vessel with its forked stigma stands off from a long spike. When the seed-vessels are ripe (in June) the forked portion opens, each half curls back, and many light, silky seeds are thrown on the wind. (Fig. 22.)

**Wider
separation
of stami-
nate and
pistillate
flowers.**

The wind helps the willow, as it helped the hazel,

but the willow has also the aid of bees, who may be seen and heard humming about the staminate flowers for the sake of a sweet juice which they find there. In any case a great quantity of pollen is wasted, but so much is produced that this does not matter. Tell the children about "showers of sulphur" and "golden rain," of which country people talk, but which are really deposits of wind-borne pollen.

**Willow
fertilised
by bees
also.**



FIG. 22
FEMALE CATKIN OR WILLOW



FIG. 23
MALE CATKIN OR WILLOW
Later stage.

Flowers on other trees.—On what other trees can we find flowers, and what kind of flowers are they? The pupils of the more advanced classes studying botany as a science would render good service to the juniors by making a collection of dried specimens of the inconspicuous flowers of common trees, and thus help the young eyes peering up into the branches that are so high above them. The flowers of the alder and elm come in March, of the ash in April-May, of the oak and beech in May.

The laburnum, horse-chestnut, and lime form admirable studies for town children a little later on.

Generalisations.—Gather up such generalisations as that (1) the flowers of many trees *need* not be attractive to insects (though they sometimes are) because they depend on the wind for transport of pollen; that (2) the loose, generally hanging catkins which bear the pollen are placed so high and poised so lightly that the wind shakes them easily; that (3) the pollen has to be abundant because so much of it is wasted; that (4) the flowers usually appear at a time when the leaves are not all "out," or before the foliage is dense, and also when the winds are very high, so that there is every chance of the pollen falling on the stigmas of the seed-bearing spike or cone, even though it be growing on another tree at a considerable distance.

Buds on trees.—The attention may now be directed to the opening *leaves*. Remind the children that if seeds are to be provided, it is not enough that pollen should fall on the stigma. The seed-bearing organs need a good supply of food. Call to their minds the nourishment packed away in the seeds they planted, and how this stock supported the seedling. Our trees, therefore, must produce leaves that these may produce food, and so the buds open and their contents expand to the light.

Method.—To explain the structure of a bud, the horse-chestnut is generally taken, and its size and accessibility make it very suitable for study. But it is by no means desirable to let each child bestrew its desk with

Demonstrate with Brussels sprout. the mangled remains of a horse-chestnut bud, though this may be necessary at the botany stage. For the juniors it is better to provide good stout twigs of horse-chestnut standing in water on a schoolroom table and let them watch and draw the various stages, especially noticing what structures fall off, what other

structures expand, and in what position. The "make" of a bud can meanwhile be interpreted by simply making a vertical section of a Brussels sprout. Each child can have one of these, and the plant with sprouts still in position on the stalk can be exhibited to the whole class.

The outer leaves of the bud are the older and larger, and they wrap round the inner ones so closely as to become quite bowl-shaped, instead of spreading out flat. The vertical section shows how the leaves all arise from the stem, the tissues of which are continuous with the ribs that branch off from it to form the framework of the leaf. These leaf-stalks come much more closely together at the top or growing-point, where we find the youngest, smallest, and palest leaves crowded together.

Comparison with the horse-chestnut.—Turning now to the horse-chestnut bud, we notice that it has more protection than was afforded to the Brussels sprout. It is sheathed in dark leathery scale-leaves which are arranged in pairs on opposite sides of the bud. These are very sticky, and glisten with resin. Let the children see how easily water runs from them; they form a waterproof coat for the buds within. When these fall back (they eventually drop away entirely), we see other scales, thinner in texture and green in colour, except at the tip, where they also are brown and sticky. Within these scales, the contents of the bud are protected still further by pads of white downy hair, in the midst of which the bud looks like a baby's woollen glove. Presently the glove opens and the leaves which it contained spread out like fingers. The stalks and the leaves themselves are still woolly, and each leaf as it opens again shows "fingers" within, for it consists of (generally) seven leaflets, each folded on itself down the midrib, and drooping in a very helpless fashion. Sometimes, instead of a terminal leaf, the

opened bud discloses a little pink cluster which is to be the future flower. The stem between each set of leaves lengthens out, the woolly hairs fall off, and the leaflets, drooping at first, spread themselves out to the air.

Other observations.—Once a typical bud has been watched with interest, the child can hardly help noticing

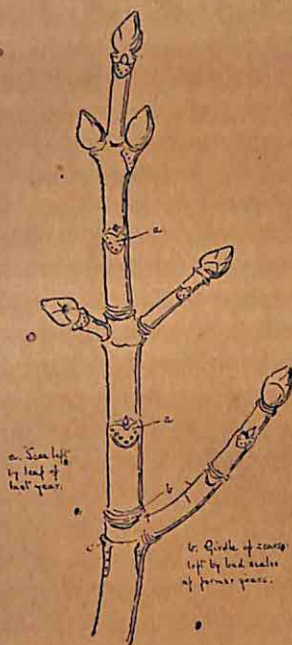


FIG. 24.—HORSE CHESTNUT, showing terminal and opposite bud. The shoot at *c* has not developed

other buds in a way that, it never dreamed of doing before. This, then, is a good time for directing observation to the way in which leaves are folded in the bud (vernation), the shape of the leaves themselves, the kinds of veins they show, and the divisions and notchings of their margins. The buds of the trees previously noticed will obviously receive most attention, but any

new specimen brought in by a child should be looked at. Such a twig should be set in water, which must be changed every three or four days, when the end of the twig exposed to the water should be sliced off. It will be interesting to the children to find what the strange twig will turn out to be when its leaves appear. The observations on the bulb (an underground bud) should be revived for the sake of comparison with these aerial buds.

Handwork of various kinds can be used. Veneration can be easily illustrated by rolling or plaiting leaves cut out in paper, and each child should make its own set. With bits of clay it can represent the opening bud structures, the result being regarded not as an art product but as an illustration. And permanent records in drawing or brushwork of the various stages of twigs and leaves will be most valuable in impressing the truth that plants being alive undergo changes and development—in other words, may be the subject of *biographies*.

CHAPTER XVI

ANIMAL FRIENDS IN FIELD AND FARM

Children and lambs.—There is something wanting in the education of a child who has not seen young lambs in a meadow. Yet many children only see the peaceable creatures of the fields as they are being driven through crowded streets on their way to the shambles. Benevolent people will often take poor school children to pantomimes during the winter; it is greatly to be wished, that these or other philanthropists would set themselves the task of organising spring excursions in April—the month of young things—so that the little ones might realise the scenery of “Bo-Peep” or “Mary had a little lamb” apart from limelights or the page of the school primer, and, from the seeing of their own eyes, might supply a commentary on Tennyson’s “May Queen” and a wealth of other nature poetry.

The poet-artist Blake has well pictured the delight and almost awed wonder of the child eyeing the lamb, and asking “Little lamb, who made thee? Dost thou know who made thee?” The insight of that strange and child-like genius has seized upon the explanation of this interest. “I a child and thou a lamb.” The lamb unconsciously provides to the child’s mind a mirror of his own playfulness, innocence, and trust. The relationship of mother and child, the keeping close to the dam, is a picture of his own dependence which is better observed in the lamb or calf than in the less sightly blind and helpless puppies and kittens which provide the

commonest analogies to infancy within the compass of the child's own home. Let him observe how each lamb knows its own mother, though all the sheep seem alike, and also "the mother sheep's call to her lamb, and the lamb's answering, each knowing the voice of the other and running wildly in search of the direction of the sound in the midst of other 'Baas' which to our ears are exactly like the cries of this particular mother and child."

Habits of sheep.—Certain characters may be noticed by all but the very little children as they watch sheep feeding either in country meadows or in the parks of big towns. The sheep not only like to live in flocks, but they like to be quite close to one another, and when they move through a gap in a hedge or through a gate they will pass one behind the other in the docile way which has become proverbial. Teach the words "ram" and "ewe," but note that sometimes ewes as well as rams are found with horns. From their Bible stories and other stories of primitive times the children will know that sheep once led a much freer life, and they can be told that these animals, like men, had a "long ago" period when they were wild and masterless, living mostly in hilly and mountainous regions. It was an advantage to them when roving in a wild or partially wild state to trust to some old and wise father of the flock to lead them out of the range of wolves, lions, or bears, or to places where better pasture could be found, and this habit persists even now.

The wool of the sheep differs from the hair of the horse or cow, and a good sequel to a visit to a field with sheep is an observation or "object" lesson in which each child is provided with a fragment of wool as it comes from the animal and finds out by experiments and guesses what has to be done to it before it can be made into flannel or any similar material.

The child can separate the fibres of the wool and notice their greasiness, which accounts for the peculiar warm, though not unpleasant, odour one observes as one passes through a flock of sheep, and which also serves to repel rain. The teacher can describe the washing of the sheep and the shearing of the fleeces. The twistableness of the fibres will delight the children, and they can be led to suggest how they must be treated to make yarn, and how the yarn can be made into a tissue. In some Kindergartens and preparatory classes children make little wooden looms for themselves and weave woollen yarn upon them, thus getting an insight into the conditions of primitive industry and travelling along the same path from experiment to industrial art by which the race has travelled to the present, incidentally learning also that in order to make use of the products of Nature man has to study their special qualities and treat them accordingly.

Adaptations for eating.—To go back to the feeding sheep out of doors, the children will see that their mode of eating is different from ours. They live chiefly on grass and short herbage, which they crop very closely, though in the winter this is helped out by swedes (a large kind of turnip) and similar food. It is not necessary for them to have the sharp tearing teeth (canine) which the children have been accustomed to see in cats and dogs, and which they themselves possess in a less marked degree. Dentition is, of course, an important factor in classifying mammals; but we can be content to let the children notice at this stage, unless a clean, dry skull is available, that the sheep does not cut through the grass on which it feeds, but grasps it between its lower cutting teeth and a hard pad which takes the place of teeth in the upper jaw, and then gives a tug in order to pull it off. Then it may be seen moving its jaws from side to side,

not up and down as we do: it is grinding the food on the flat-crowned teeth in the cheek. But the sheep does not chew its food directly it has been bitten off; it is swallowed at once, while the creature keeps on eating. But afterwards the swallowed food is brought back to the mouth and chewed at leisure (chewing the cud). Tell the elder children about the four stomachs of these ruminating animals—two of which are merely pouches to hold the food until a convenient time comes for chewing. Explain this also by reference to the old times when wild sheep, in fear of large beasts of prey, would snatch a hasty meal on the lower grass-lands and then depart to safer places among the hills where they might digest it in peace.

Adaptation of feet.—The long legs of the lamb will certainly be noticed, as also those of the calf or foal. Young children are puzzled as to why the legs appear shorter as the creature grows older. Try to make them understand that the limbs grow faster than the body *at first*; but that afterwards the body grows, so that there is not such an apparent contrast. A sheep's foot may be watched in the field, and a specimen obtained from a museum in order that the children may see that the "foot" is really the points or tips of *two*

Comparison with human limbs. toes cased in a very hard substance like our nails—but stronger. The portion of the limb corresponding with our shoulder or thigh is under the wool, where is also the elbow or knee-joint. The joint seen in the leg of the animal as it stands is really our ankle (or wrist), and all below that is the foot (or hand) raised from the ground. Above the two cased toes may be seen the remains of two other toes which are not used. Teach the term "cloven hoof," given on account of the cut or cloven appearance of the foot; but insist

The so-called "cloven hoof."

on the presence of the *two* distinct toes, in order to emphasise the difference between the various families of ungulate or hoofed animals. Notice that the creature moves on the tips of its toes; this gives it much more lightness, especially in climbing on its native hills, than would be possible to a creature walking on its soles, as men and bears do. Let them notice how, if alarmed, a sheep will strike the ground with its *front* feet. A rabbit makes a similar signal with its *hind* feet.

Comparison with deer.—Comparisons can now be made with other hoofed animals the children are likely to see. Deer are kept in the municipal parks outside most large towns, or in enclosures in urban parks. They resemble the sheep in having a "cloven hoof"—*i.e.* two toes with hard casing, and in chewing the cud. But the so-called horns of the deer (the stag only has them) should be called by their true name—antlers;

Antlers
distin-
guished
from horns. they are different from the horns of the cow or sheep in that they are formed throughout of lifeless bone, and are shed every spring, when new ones take their place. At first they look like little velvety knobs; but they rapidly grow and branch into a new pair, which is more branched than the pair it replaced. Thus the age of a stag is indicated by its antlers. The children are not likely to hear the clashing of the antlers of fighting stags which make such a terrifying sound in the still autumn woodlands; but they can be told that the antlers are used as weapons when the creatures are wild.

The cow: also an even-toed ruminant.—The mild-eyed domestic cow is a ruminant also, and, like the sheep, has a pad in place of the upper cutting teeth. Notice how the cow uses her tongue when she eats. Give the children the question so time-honoured as a "catch" in observation, "At which end does the cow begin to get

up from the ground?" She has a cloven hoof—i.e. two toes. Her horns are not wrinkled like those of the sheep, but smooth, and they do not fall off, in which they resemble those of the sheep, goat, and antelope. They are hollow cases enclosing a bony core.

The goat and its value.—It is worth while for economic reasons drawing the attention of the children to the goat, and telling them of its value as a minor dairy animal. They will see its cousinship to the sheep; but its greater restlessness and leaping movements make it a more interesting pet, and, unlike the sheep, it will thrive in the paved yards and courts of towns. Mr. C. J. Cornish, the late well-known writer on animals, says: "In parts of New York the city-kept goats are said to flourish on the paste-daubed paper of the advertisements which they nibble from the hoardings. It is beyond doubt that these hardy creatures are exactly suited for living in large towns. Bricks and mortar and paving-stones exhilarate them. Their spirits rise in proportion to what we should consider the depressing nature of their surroundings. They love to be tethered on a common, with scanty grass and a stock of furze-bushes to nibble. A deserted brick-field, with plenty of broken drain-tiles, rubbish-heaps, and weeds, pleases them still better. . . . Not even the pig has so varied a diet as the goat."

The pig: an even-toed non-ruminant.—The pig does not ruminate like the sheep, goat, ox, and deer, but, like them, it is a hoofed animal, and has an *even* number of toes—four. Its third and fourth toes are large and rest on the ground, while the second and fifth are very much smaller, though distinctly hoofed—so that the four toes can be clearly made out. The thumb is absent. The snout with its broad disc has not so much work to do as in the days when swine were wild in the woods, or were driven in herds by swineherds,

such as Scott's Gurth in "Ivanhoe," to dig for roots and for buried nuts, and its function must be explained by description of these ancestral habits.

The horse: an odd-toed, hoofed animal.—The horse and the donkey are *odd-toed*, hoofed creatures. The knee of the horse, of course, corresponds with our wrist, and the hock with our ankle. The whole of the limb below these joints is the middle finger of our hand or the middle toe of our foot, and the hoof is the protected tip of this finger or toe. The hoof is broader in the front than in the hind limb. To prevent injury from nails, sharp stones, and hedge cuttings, we still further protect the hoof by an iron shoe; but this process, if the blacksmith is careful, does not hurt the creature, because, like our nails, the hoof has no nerves. The horse has six broad sharp cutting teeth in the front of each jaw, and there is a long space between these and the cheek teeth, into which the bit is fitted.

Town teachers often lament that they have not enough material for Nature study, but Mr. Cornish has pointed out that the immense population of horses in London includes all sorts and conditions, each fitted to some special work, and he cites a very interesting book, "The Horse World of London" (Religious Tract Society), by Mr. W. J. Gordon, which would be a mine of interest for a teacher with a class of lively boys. There is yet time before the motor industries drive them from the streets to make fuller acquaintance with the animal who has done more than any other to bring men into civilising relations one with another.

CHAPTER XVII

GOLDFISH AND TADPOLES

It takes more than an ordinary effort of imagination to realise the conditions of life in an element other than our own ; but the attempt has always been a fascinating one alike to fiction and to science. There is no doubt that a great part of a child's delight in watching fish in a brook or pond lies in the pleasant shock of finding creatures living apparently very happily in a medium which would be impossible for himself. Kingsley, as we all know, has made use of this incongruity in his delightful "Water Babies," and one of Froebel's best song-games for the children deals with the same theme. The love of watching water seems to be a primitive instinct, and it is this feeling in children which makes a visit to a pond or stream, or even the keeping of an aquarium, an invariable success so far as their interest is concerned. Now, an ordinary pond is a whole world in itself ; its flora and fauna on margin, surface, and in depths will yield material for years of study. But with young children one must choose objects that are fairly large, easily accessible for continued observation, and such as make some specially striking appeal to the senses. It would not be advisable, for instance, to try to begin the study of pond life with the water-boatman, interesting as it is to more advanced pupils. All improvement in observation, it must be remembered, depends upon

**The charm
of water.**

**Study of
pond life.**

the recognition of still finer and finer differences of form, and upon the gradual interpretation of these differences in the light of the precepts and general notions that have already been gained.

Starting-point: "What is a fish?"—Children are in the habit of describing all water creatures compendiously as "fish." As a beginning, therefore, it will be well for them to learn what are the characters of a fish, that they may test other "finds" by this standard.

Unless, therefore, they are fortunate enough to live near a fish-stocked stream or pool, it is well to let them observe goldfish in a bowl, aquarium, tank, or tub. (In preparing a home for fish, care should be taken to give them a clean, sandy, gravelly floor, pieces of stone arranged so as to form hiding-places, and water-weed to assist aëration of the water.) The children will notice how easily the water parts before the doubly wedge-shaped body of the fish, and how the creature moves its tail and other fins in swimming. Let them try

The fins and their movements. to count the fins on the goldfish and then compare with a herring. Let them draw both these fish and also notice others lying on the fishmonger's slabs. There is the big

tail fin, a fin on the back, another on the belly towards the tail. These are *odd* fins, but in addition to these there are two *pairs* of fins which correspond with the arms and legs of the higher backboned animals. In the case of any fish observed, let them notice such details as the size of the scales and the number of rays in the fins, as well as its colouring.

The following extract from the excellent little hand-book sold for a penny at the Stepney Borough Museums and at the Horniman Museum (London County Council) gives very simply an account of the fin movements of a fish, which may be useful to teachers. "Fish swim

chiefly by the tail, which is used in a sculling manner. The dorsal or back and the anal fins are used to maintain the upright position of the fish in the water when moving slowly, acting in the same way as a boat's keel. The front or pectoral pair of fins is used in several ways; as oars, when quickly swimming; as steering oars, by using one side only at a time, whilst the opposite is kept close against the side of the body; or in assisting the fish to ascend or descend, by simply maintaining certain angles whilst the fish swims by means of its tail. The ventral pair of fins varies in position, and is mainly used for balancing. All these motions may be seen by watching the fish in an aquarium. When the fish is swimming rapidly, both the paired fins are held close to the body in order not to impede progress by any projection."

The goldfish does not need constantly to come to the surface, as we should wish to do, in order to breathe. The

How a fish breathes. gills of a herring can be shown and the children can see how it is possible for the water to pass through the mouth into the gill chamber (insert a skewer). Here we find fringes or brushes hanging down so that the water washes over them. Near the surface of the filaments of the brushes are tiny blood-vessels, and the water gives up to them the air dissolved in it. Then it passes out through slits in the cover of the gills just behind the head. So that we may say that a fish is a backboned creature whose limbs take the form of fins and who breathes air through gills instead of through lungs. The teacher can add that its blood is much colder than ours, so that it can live in water without discomfort.

Tadpoles.—After the goldfish a tadpole is perhaps the simplest subject for a school aquarium, and it has the advantage of being specially instructive as an example of metamorphosis, of change and transforma-

tion to meet varying conditions. The tadpoles can be seen wriggling about in almost any pond or ditch from March onwards, and the children will almost certainly, on a first encounter, hail them as fish. With a net improvised from muslin slung from a bit of wire bent into a ring and fastened to a handle, we can catch the spawn that is seen floating on the surface of the ponds and thus secure a supply of tadpoles from the earliest stage. (Any naturalist will procure them for the centrally urban teacher.) If there is no aquarium, the spawn can be placed in a small tub, or even in a pie-dish, but care should be taken to have also a plentiful supply of green weed (*anacharis* is extremely common). The spawn consists of a large number of tiny round bodies lying together in a mass, but "spaced out" from one another by a glassy envelope. The children can be told that these eggs were laid by the mother frog in the pond, and that afterwards both she and the father frog departed to dry land, leaving their offspring to take care of themselves. It seems to be a rule that creatures who have very large families give themselves very little trouble over their education, and herein the frog resembles the fish.

The egg stage.

The children can compare with the robin and the rook, whose small families were satisfactorily launched in life. But Mother Nature has made up to these little creatures for the neglect of their proper parents. The jelly-like bag, in the first place, protects the eggs from water-haunting birds and other creatures on the lookout for a meal, who find that the slimy mass only slips away from their open mouths. Notice, too, how it acts as a float to keep the eggs exposed to the light, warmth, and air, yet without crowding them one against the other. There are large numbers of them, because comparatively few only will survive the perils

of the pond when they are once hatched, and Nature provides a large margin to allow for these accidents. At first each little egg is partly black, partly white, but in about four days the whole of the egg is black, and its shape is now a long oval, or rather a sphere with a streamer. Within the lengthened egg may be seen forming the head, body, and tail. In about two weeks the jelly-like covering bursts and a tiny black creature,

The fish-like stage. all head and tail, comes out. It is fish-like in its ways, to be sure, but it has no fins; it wriggles about in the water by swift jerks of its tail. It has no scales; on the contrary, its body is very smooth and soft. It may be seen with a group of its brothers fastened by its head (which is provided with a kind of sucker) to a water-weed or to the side of the aquarium. It is not eating, however, for it has not yet a mouth, and is only nourished by food it has within its own body (the yolk of the egg), though it is thought that it may absorb food through the sucker. By-and-by the members of this black bunch become more active; they now have mouths of their own and move about feeding greedily on the water-weeds. In an aquarium this diet must soon be supplemented by bits of bread, dead fish, and dead worm. The young ones will be seen to have little brush-like bodies standing out at the side of the head. These are gills like those of a fish, but uncovered; presently a fold grows over them so that they are no longer seen.

The tadpole is now more than an inch long and still looks like a fish with a broad tail for its size. But by-and-by little knobs show themselves at the part where the tail appears to join on to the body, and these are seen to grow into limbs; but they are not fins, for they are jointed, and within a week toes appear at the ends. (The

Appearance of limbs.



FIG. 25.—A FROG AND TADPOLES

tadpole is now about two months old.) These are the hind limbs of the future frog, and as they are twice as long as the front legs of the grown animal, so they are the first to appear and are the most conspicuous. The front limbs are at first hidden under the fold which covers the gills, but now these also come through.

The eyes, which formerly were sunk in the head, now appear on the surface, and the mouth becomes larger.

**Transition
to frog
stage.**

The tadpole may be seen rising to the surface of the water and taking in air as a frog does, for its true lungs are forming.

As the legs grow, so that they can be used in swimming, the tail gradually shrinks, for it is being absorbed into the substance of the body—a useful arrangement—since at this stage the tadpole has very little appetite. Now is the time to provide an island or a grassy margin in the aquarium on which it may come forth, for our unprotected pond-baby, after passing through its fish-like infancy, is now a fully-formed frog. A series of *dated* drawings made by the children will show its life history up to this stage. In the next chapter we shall study its new way of life.

CHAPTER XVIII

THE FROG AND ITS RELATIONS

The frog a terrestrial animal.—We have seen that our unprotected pond-baby, the tadpole, is not so helpless as one might suppose, considering the behaviour of its parents. To compensate for the want of their care, it has a shape and breathing organs which enable it to live in the water, and here, also, it can find its food. But it is not intended to be a water-creature all its life, and when it becomes a fully-formed frog it migrates to the land. It likes to live *near* the water in moist grass along the shores of ponds or streams, and it will plunge into the water when alarmed, or when it wishes to cool

Love of moist places. its skin. It hides in the mud at the bottom of ponds in the winter, and in the spring its eggs are laid in ponds and ditches.

But during the period of the year when it is active, we shall find that it is a terrestrial animal, and it is cruel to try to keep a frog in an aquarium where there is no platform for it to rest upon. It is also cruel to keep a frog in a dry place, for it suffers much if its moist skin becomes parched. It is better to move it to a terrarium or box with glass sides and perforated zinc cover, the floor of which is composed of earth and sand, with tufts of fresh grass, some big stones for hiding,

Food. and a pannikin of water. It must be fed with *live* worms, earwigs, or slugs, for *motionless* prey does not seem to arrest its attention. But the frog also likes flies, which are not so easily

supplied, and, on the whole, it seems better in ordinary cases to keep it under observation for a day or two only. Then it will be kinder to take it to the water's edge, unless, indeed, its owners have a garden with moist sheltering-places available, where it will be extremely useful in keeping down garden pests, and can generally be caught, when wanted, during the summer. The full-grown frog is as interesting in its way as the tadpole. Some children will affect not to like the feel of its cold, smooth, moist skin; but they should be reconciled to this by being told that it helps the frog to breathe. Its *colour* is greenish-brown and very

Coloration. indefinite; but therein lies its interest, for it varies in tint according to whether the creature is squatting in the grass, when green predominates, or whether it is moving over the clay at the water-side, when it is brown. This is evidently a great advantage to the frog, for its soft body is quite defenceless; it has no weapons, not even the offensive juice secreted by its cousin, the toad. The jump of the frog, whereby he escapes from his enemies when disturbed, always amuses children; let them notice how powerful are the hind legs which perform the movement. The

Limbs. toes are webbed to help in swimming, when the animal, who, as we have said, haunts the water-side, plunges for safety into the water itself. It is the great length of the hind limbs which gives the frog such a curious humped appearance when it is squatting (p. 135). The front feet are smaller,

Tongue. and the toes are not webbed. If the frog can be watched while feeding, the children will perhaps see the curious movement of its tongue. It is fastened to the bottom of the mouth in front, and it is thrust out so rapidly as to be almost invisible. This occurs when the meal consists of a small creature, such as a beetle. Directly the prey moves, the tongue darts

forward. Its tip is provided with a sticky fluid, so that the creature is glued, as it were, to it. Large prey, such as worms and slugs, are grasped by the jaws. The eyes stand out from its head, as do also, to some extent, the nostrils; this is a great advantage when the frog is swimming, for it can thus both see and breathe while the rest of the body is under water. The breathing of the frog is interesting. It breathes through its nostrils, keeping its mouth shut, and the throat is seen to swell as the air comes in, and to sink as it is breathed out again.

During the winter, when insects and slugs are not to be had, the frog would die of famine if it did not adopt the device of many creatures in like case and hibernate. A number of them will huddle together for warmth in the mud at the bottom of a pond or in drain-pipes used on the farm. Any one who keeps a frog as a garden pet must expect to lose sight of it for this part of the year. No food is needed, for the creature is not active, and sufficient air is obtained through the pores of the skin. The frog is a cold-blooded creature, and this amount of exposure does not hurt it.

Comparison with the toad.—The frog is often confused with the toad, and it is worth while making clear the difference. The frog's skin is smooth, whereas that of the toad is thick, and studded with bosses or warts. It is from the skin of the head that a substance is secreted which has caused the toad to be described as venomous, and, indeed, a dog sometimes suffers very much after seizing a toad with its mouth. We must not forget to follow Shakespeare in making the children notice its beautiful eyes. Perhaps it was the conjunction of these fine eyes, with its awkward body and "venomous" skin, which caused the toad for so many ages to be regarded as an uncanny creature—a

companion of witches, or a witch in disguise. Now the tables are turned, and Dr. Hodge, in "Nature Study and Life," urges American children, almost as a patriotic duty, to keep toads as pets in order to reduce the insect swarms which play such havoc with the food of the people. English children, too, should be told *never* to kill a toad, for the same reason.

Habits of the Toad.—The toad cannot jump like the frog, for his legs are shorter, his body heavier, and the



FIG. 26.—THE COMMON TOAD

hind legs are not nearly so large in proportion to the front. He "swaggers" along, as Mr. Phil Robinson says, with his elbows out, like a dandy. Shelley calls him the "slow soft toad," and, indeed, he cannot hop more than about three inches. He hides during the day in moist, cool places, and comes out to feed chiefly in the evening. The mother toad lays her eggs in ropes of jelly, not in masses like the frog. The toad-tadpoles pass through the same stages as the frog.

Both parents come back to land and stay there; the toad is much more of a land animal than the frog.

The newt.—Another creature which is a puzzle to children, both as to the category to which it belongs and as to its mode of life, is the newt or eft. It is easily found in ponds by country children during spring and summer, but it need not be a stranger to a town child. The writer, on visiting the Nature Study Museum in the Borough of Stepney—a disused mortuary which



FIG. 27.—MALE AND FEMALE OF COMMON NEWT

has been converted into a fairy-land for children—was escorted to the features of the exhibits by a fellow-visitor, a small boy of ten, who, after the close of afternoon school, had come in to look at his particular pets. He seemed to take a special pride in the newt, which was lying contentedly on the rock peninsula which jutted out into its pool. The Horniman Museum, in South London, also has a gallery specially devoted to vivaria and aquaria; and it is to be hoped that other

local museums will shortly follow these good examples. Stuffed creatures, however well arranged, can never have the charm of creatures living their life in surroundings which simulate their own homes.

The newt has had a watery career, resembling that of the frog or toad tadpole; but, unlike them, it has *not* lost its tail, which is large, flat, and very useful for swimming. Its legs are short, and it cannot leap at all.

If the children have seen lizards, they may at first

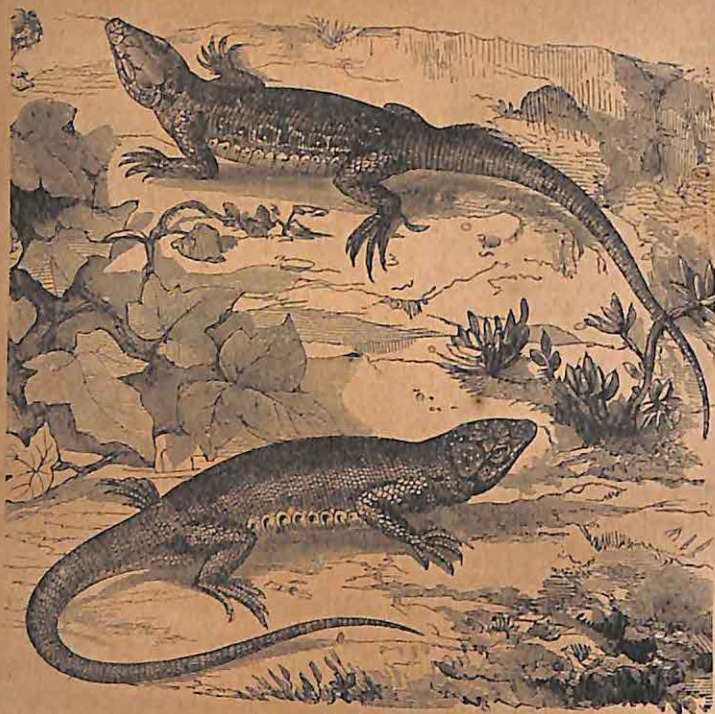


FIG. 28.—LIZARDS

think that the newt is a lizard, because of its elongated body and short legs. Remind them that lizards are

generally seen in *hot, dry* places, on sunny banks and the like; whereas the newt always likes moisture, and accordingly has a soft, moist skin; on the contrary, a lizard's skin is dry and covered with scales. A baby lizard is like its parent, but a newt was once a tadpole. In short, the newt, like the toad and frog, is an amphibian, while the lizard has only one mode of life.

**The newt
and the
lizard.**

The name "amphibian" will gratify the children, who are delighted with a long word now and then; but they must be taught to use it carefully, and not call a duck, for instance, an amphibian. It must be applied to creatures which spend *the first part* of their lives wholly in the water, and take to a land life when mature.

**What is an
amphibian?**

CHAPTER XIX

BIRDS OF SUMMER—SWALLOWS, MARTINS, AND SWIFTS

The swallow. The beauty of its motion.—The first swallow-flight seen by a town child who has only read or heard of it is a memorable event, perhaps for the whole of life. And the return of the swallows in spring is a red-letter day in the bird calendar of the country child. The fascination which a child feels in watching the evolutions of swallows skimming over the surface of a pool is, no doubt, due partly to an instinctive love of motion as such, and partly also to the unconscious æsthetic appreciation of the beauty of the quick turns and ever-changing curves against the quiet horizontal plane of the water. By standing quite still, the child may get a clearer view of the creature as it wheels past

**Beauty of
form and
colour.**

him. Then he should notice the sharply pointed "streamers" of the forked tail and the row of white spots above these drawn-out tips. The colour of the back and throat, which seemed at a distance to be black, is now seen to be purple, with chestnut on the head and throat. There is a belt of blue across the breast, and below this the plumage is creamy white (p. 147).

Adaptations for getting a living.—The question "What is it doing?" inevitably comes, and the reason of these incessant movements must be explained. Whereas the robin hopped about the ground and the rook poked into the soil, both in search of creatures living in or quite close to the earth, the swallow skims

hither and thither, because its food consists of small insects which live in the air above the surface of the ground or the water. It very rarely alights to pick them up. The rook, as we saw, had a bill specially fitted for boring in the soil; the swallow, on the other hand, has a soft bill, not in the least fit for boring, and a mouth with a very wide "gape." It flies with its wide mouth open nearly to the eyes, so as to snap at the insect without loss of a moment, and the snapping is performed so quickly that we cannot see it. It has an enormous appetite, as is natural when one considers how very much energy it must exert in its incessant movements. As it flies, it cries "Twit, twit," but when it is greeting another swallow it says "Tit, tit, tit." Besides the well-known twitter, the male bird has a very sweet song, which we can hear sometimes in summer as he perches on a roof or the top of a post. Swallows do not care to explore trees, for their long slender wings and tail-tips would suffer by brushing through the leaves. Their feet are so small and weak that they walk with difficulty; this is why they so seldom alight on the ground.

The nest.—The nest is made of mud, which the bird collects with its beak from the edges of puddles, pools, and streams. It carries the mud in its mouth in little balls, and brings it to the chosen spot. This is almost always under cover—the ledge of a chimney, or the beams supporting the roof of a barn or shed, are favourite sites (fig. 29, p. 146). The bird clings on to the wall or ledge with its little weak feet, and daubs on the mud so as to make a half-cup, open at the top, its base resting on the ledge and its side cemented to the upright wall or joist. Just as builders put hair into mortar to hold it together, so the swallows bind their mud with bits of straw, hay, and hair, &c., if they can get them. Then, for comfort's sake, the nest is lined with grass and feathers. Three or four

pairs like to build together in or against the same chimney or barn. The swallow, like the rook, prefers to return to the same nesting-place every year, and builds a new nest near its old one. The young are fed on insects, and when they are old enough they seem to receive lessons, first in perching, then in flying, and then in catching their food.

Autumn journey.—Unlike our ordinary song-birds, which moult in thickets during the latter part of the summer, the swallows are active all the time they are with us, and only moult while absent in the winter. When insects fail, swallows congregate in large flocks, for the time has come for their departure to North Africa. We can see them sitting and twittering to one another on the telegraph wires or on the roofs of barns. Perhaps they are arranging the details of their southward journey. The mystery of their finding their way across Europe and back again has long been a puzzle which is only restated and not explained by using the word "instinct." It is thought that they find their way by remembered landmarks descried from their lofty height, and that the old ones of the flock are the guides in successive seasons. It must be remembered that they need cross only comparatively narrow seas, and have very keen powers of sight. When the hot, dry winds return in the summer of North Africa, and insect life suffers as much as it suffers from a northern winter, the swallows come back to us again, for by this time there is plenty of the food they want.

The house-martin, or cave-swallow.—The cousins of the swallows are the house-martins. They can be distinguished from the chimney-swallow by having no colour about the white breast, and a white patch across the top of the tail. Perhaps the children may have heard the story of St. Martin, who gave his cloak to a beggar. According to the legend, the white patch

represents the white garment under the cloak. Here, perhaps, we may point out how the old English names were given in a friendly way to favourite creatures, such as the Robin, the Martin, Jim Crow, Jenny Wren, and so on. The martin has not the long points to its tail which are so unmistakeable in the swallow.



FIG. 29.—CHIMNEY-SWALLOW AND HOUSE-MARTIN

Its neighbourliness towards man.—The martins build their nests even closer to man than the swallows, for one often sees the little cuplike structure of mud quite close up under the eaves overhanging a cottage door or above a window. The little circular hole at the top is

protected by the eaves, and from the doorstep or open window one may often see the heads of the little ones filling up the space between. The house-sparrow is an enemy of the house-martin, and will frequently turn a pair out of their finished nest. The cottage people try to shoot the sparrows to prevent this, for apart from their sympathy with the rightful owners of the nest, they know that martins under the eaves mean less trouble from gnats and midges during the summer. The house-martins are even more sociable than the chimney-swallows, and many pairs will build their nests under one roof.

The sand-martin. The nest in a tunnel.—The sand-martin is a brownish bird, and therefore is easily distinguished from its relatives, the swallow and house-martin. In the nesting-time we see it flying in and out of holes in sandy banks. For this little creature



FIG. 30.—SAND-MARTIN

is a most devoted parent, and though we cannot but suppose that, like all birds, it loves air, yet to ensure the safety of its children it actually burrows in the sand a tunnel which is often 3 feet long, and may extend to 6 feet. These holes slope upwards from

the opening to the nest, so that any moisture which may find its way into the tunnel is drained away. The bird has no tool but its beak, which, though small, is strong and shaped like a wedge. Like the swallow, it clings with its little feet to the side of the quarry or railway cutting where it is scratching. In passing such a spot, we notice how many of these little holes are seen together, for the sand-martin is particularly fond of having his fellows about him. Sometimes twenty or thirty openings can be counted in the side of one gravel-pit. Each of these little tunnels has at its farther end a rough nest of dry grass and rootlets, where the eggs are laid and the young brought up. The nest is very loosely fashioned, for obviously the tunnel itself is a sufficient protection, and a soft bed is all that is necessary.

Swifts.—The swift, though it is somewhat like the swallows and martins, is not a very near relative. Its colour is almost entirely black, and it has a very long, slender wing and a forked tail. The old rhyme,

The big black swift you're sure to know,
Shaped like an arrow in a bow,

gives a very good reminder of its shape. The ends of the bow are the tips of the long black wings, and the hinder or feathered part of the arrow is the tail, which is not so deeply forked as that of the swallow.

Their flights in the high air.—Swifts are high-flying creatures; they live upon those insects that haunt the upper regions of the air, and accordingly they make their nests in lofty places like church towers. Before they take their flight for the winter, we may see them wheeling round and round the tower, and hear them shrilly screaming "Squee! Squee!" They do not sing. These gatherings resemble the conferences of the swallows, and perhaps the purpose is the same—to arrange the details of the long journey that is before

them. They fly much faster even than the swallow, and their name well marks their chief distinction among birds.

It may be convenient to give approximate times when the children should look out for the coming and going of these birds.

The swallow comes about the middle of April, and leaves towards the end of September. The house-martin comes usually a little later than the swallow, and also leaves somewhat later. The sand-martin



FIG. 31.—SWIFT

comes in mid-April (rather before the swallow), and leaves in October. The swift comes later than any of these—at the end of April or beginning of May, and leaves earlier (before the end of August).

Aids to interest.—Let the children see pictures of each of these birds in a characteristic attitude and haunt. Make the story of their start, and their passage across Europe, as vivid as possible.

When raindrops bubble in the pool
Upon the roof the swallows hold
Their gatherings like a noisy school ;
" See, here is winter and the cold."

All cry, "How many leagues shall slip
To-morrow beneath our flying band,
Brown plains, white peaks, blue seas that dip
Their foaming fringe against the land!"

(Translated from ALFRED DE MUSSET.)

And the teacher may find in Mr. Hilaire Belloc's little book, "Esto Perpetua," a charming description of those fascinating regions of North Africa which are their winter haunt. Their haunt—and not their home, for "home" to all these migrants is the limit of their northern flight—the place where the nest is made and the young are reared.

CHAPTER XX

THE PLANTS OF THE HEDGEROW

The festival of the May.—Some schools have tried to revive the ancient festival of May Day, but there is often something theatrical in the effect produced. The promoters have perhaps overlooked the fact that owing to the introduction of the "New Style" in our calendars, the 1st of May falls eleven days earlier than it used to do. The old Hitchin May song runs:—

A branch of May we have brought to you,
And at your door it stands ;
It is but a sprout, but it's well budded out
By the work of our Lord's Hands.

"It is but a sprout" even on the 11th, for the date of the full blossoming of may, called also whitethorn and hawthorn, is a little later—the 13th or 14th. A *mid-May* festival might conceivably be less of an artificial indoor pageant than one held on the 1st; at all events, the blossoming of the hawthorn might well be the occasion of a half-holiday spent in a walk along a hedgerow. For the hawthorn deserves celebration: it is the characteristic tree of the English hedge; and we can only realise how much it adds to the beauty of the landscape when we have seen districts in which it is replaced by stone walls, dykes, palings, or, still worse, by barbed wire.

The hawthorn.—It will grow to the height of twenty feet, though it is seldom allowed to do so. For if it

grows to its full height it loses its value as a hedge-tree, since so much of the sap goes towards the growing points above that the growth of the lower buds is arrested, and bare spaces are left between the stems through which intruders, human and beasts, might creep. So the tree is more often reduced to a bush. This is done partly by forcibly turning some of the shoots in towards the hedge and also by lopping and "trimming" on both sides of it. Then the buds which have lain dormant have an extra food supply and they accordingly lengthen out, filling the gaps between one tree and the next. Its thorns make it very useful as a barrier, and moreover it grows easily and quickly. If we want to enclose a plot of ground or fill up a gap in an existing hedge we can plant a cutting of hawthorn. The cuttings are "quick" or living; they will form roots at the base of their stems and soon become the "homely, quickset hedge" of which Tennyson speaks.

Let the children notice the peculiar branching of the hawthorn, how, when they are gathering "may," they will find short twigs on the lower part of the branch and much longer twigs straggling off near the summit.

Let them feel the thorns and try to detach them, comparing them with the prickles of a neighbouring bramble. The prickles of the bramble or of wild rose can be pulled off; the spines of the hawthorn

Haw-thorns resist. In the angle between the thorn and the stem they will find a tiny bud; this shows us that the thorn is really a branch and not merely a growth from the surface, like the bramble or wild-rose prickles. These thorn-branches, instead of bearing soft green leaves, have sharp, hardened tips, which act as the armed defenders of the plant. Help the children to realise that the enemies of the hawthorn in its natural state were browsing animals who would devour the young and

tender leaves. The leaves which, though simple, are much cut, should be compared on the one hand with **Its leaves.** such simple uncut leaves as the tulip or the privet (the latter also a common hedge plant), and on the other with the leaves of the bramble or wild rose, which are compound, *i.e.* having lobes extending quite to the midrib so as to form separate leaflets. It is much better, whenever possible, to illustrate these points of structure from plants that have been actually known as *wholes*, especially if they grow in the same neighbourhood, rather than to give a set lesson on "Compound Leaves" illustrated by a collection of miscellaneous specimens of leaves shorn from their stems.

The fragrant blossoms of the "may" itself may now be looked at closely. The buds are shut in by **Its blossom.** five green hairy sepals, which afterwards bend back. The open blossom is a cup formed of five rounded white petals, and within this there are about twenty stamens which have red anthers, and thus give, with the petals, the white and pink effect that is so charming. The seed-vessel within is roofed over by a flat green top, and the green knob below will ripen into the crimson "haw." The bunches of haws linger on until late in the winter, for in spite of their attractive colour they are so hard and tasteless that birds do not eat them until other food is exhausted. The children may be asked to notice the red "may" which grows in parks and suburban gardens. In this case the plant has produced double flowers—that is, an extra number of petals, but it has done so at the expense of the stamens and also of the scent.

The blackthorn or sloe.—The hawthorn blossoms are not the first in the year to beautify the hedgerow. If our walk be taken in March we shall see slender pointed rods, looking at a little distance black as ebony,

and crowded with white starry blossoms with no touch of pink or other colour upon them. The branches are beset with thorns and end in a thorn, and there are rarely any leaves when the flowers appear, so that the contrast between black and white is quite unbroken. This is the blackthorn. The blossoms of the wild may or whitethorn are in reality less white than those of the blackthorn, but the adjective *black* marks the colour of the branch itself. If we take the same walk in autumn we shall hardly recognise our blackthorn again, and shall probably call it by quite another name—the sloe-tree. The stems and thorny branches will be partly concealed by the small simple leaves: the beauty of it now consists in its clusters of purple downy fruit—a kind of wild plum very sharp to the taste. The tree-wild plum, whose branches have no spines, may also be found in the hedges.

Other hedge trees.—The children will often find hedgerows largely composed of taller trees than the hawthorn or blackthorn. Sometimes a forest tree is planted or left growing in a hedge, its bole filling in the spaces between the lower trees. Limes, beeches, and hollies are sometimes cut and lopped so as to make a wall of their short stems and twigs. The service-tree, the dog-wood, the spindle-tree, whose pink and orange fruit is so beautiful in the autumn, the hazel, and the elder are all to be found in hedgerows; nor must we forget the hedge-maple, whose lobed leaves, smaller than those of the plane-like maple or sycamore, are not unlike the hawthorn leaves. And over and amongst the hawthorns and blackthorns and other hedgerow trees we find plants with long, weak, straggling stems, which nevertheless contrive to tantalise us with trails of lovely blossom, and later with bunches of fruit, high above the reach of our arms. Some of these climbing plants, such as the honeysuckle, the bryony,

the convolvulus, will be more interesting later on, but in May the interest of future blackberries will prompt children to notice at least the bramble.

The climbing plants.

This is almost an evergreen plant, for some of the old leaves have given a touch of green to the hedge all through the winter.

In May the new green leaves of this year will be seen on the same branches, and also the white blossoms. Let the children notice how the bramble behaves. It climbs, or rather scrambles, up as high as it can by holding on to the other plants with its downward pointing prickles, and when it finds no more support it arches over towards the path in beautiful elliptical curves. The hedgerow affords a good opportunity of filling a gap in the Kindergarten lessons on *form*, and the teacher may draw attention to the fact that Nature's favourite form is the ellipse, as seen in leaves, the eggs and bodies of birds, and in the curves described by outgrowing branches.

The Rose Order in the hedge.—The wild rose climbs and trails in the same way. In June, when the "may" is over, the hedges will be gay with its exquisite flowers. Let the children also notice the compound leaves with the little ear-like growths at the base of the stalk. It is convenient that the hedge affords so many examples of the same botanical order—Rosaceæ; thus we have blackthorn, hawthorn, and wild rose, and the children, though they do not yet need the nomenclature of classification, may compare the blossoms to find how they resemble one another, and how the seed-vessel is in each case *below* the other parts of the flower.

The smaller plants of the hedge.—We have been speaking so far only of the actual hedge. But a hedge is often planted on a raised bank, and at its foot there may run a ditch, which may be either wet or dry; also there is often a strip of grass between the roadway or path

and the hedge itself. Each of these regions has its own flora, which again may vary according to situation and climate, so that our hedgerow walk may yield suggestions for years of study, and as a result relieve alike town and country dweller from that vacancy of mind which is both piteous and dangerous. For it makes a great difference to an outdoor saunterer whether the hedge is just a green hedge and nothing more, or whether it consists of a number of plant acquaintances each having its own name, graces, and ingenious ways of living.

Plant competition in the hedge.—Plant life at the foot of the hedgerow is generally crowded, and this means competition for light and air. Some bushy plants, as we have seen, scramble *over* the hedge by their climbing prickles; others, which are weak herbs, send up tall stems, such as the mallow, the mullein, and the big umbelliferous plants of the hedge. Some have very finely cut fern-like leaves, through which the light can filter to their brethren below them on the parent stem, such as the hedge-parsley; others spread out their leaves to form a mosaic, such as the small-leaved varieties of ivy which clothe the hedge-bank. Our old friend the coltsfoot, whose flowers appeared in March, by May spreads out its leaves over quite a large area on the tiny landslips that occur on the side of the ditch.

Wild flowers of the hedge.—The teacher is recommended to procure a little book called "How to Find and Name Wild Flowers" (Cassell, 1s. 6d.), which shows how to recognise the wild flowers of this country according to their colour, time of opening, habit, habitat, range of growth, &c. Thus equipped, the hedgerow, its bank, its ditch, will soon become a familiar and happy region to his pupils.

The following are some of the commoner flowers to

be found along hedgerows during the spring and summer :—

February.—Chickweed, shepherd's purse, dog's-mercury.

March.—Dandelion, coltsfoot, moschatel, red dead-nettle, violet, blackthorn, speedwell.

April.—Greater stitchwort, wood-sorrel, white dead-nettle, garlic mustard, wild beaked parsley, cuckoo-pint, red campion, herb-robert, soft crane's-bill, primrose, ground-ivy.

May.—Buttercup, yellow rocket, ivy-leaved toadflax, ragged robin, hawthorn.

June.—Great bindweed, elder, upright bedstraw, goose-grass, rough chervil, St. John's wort, mullein, agrimony, hedge mustard, purple vetch, small bindweed, flowering rush, tufted vetch, honeysuckle, foxglove.

July.—Traveller's joy, yellow toadflax, hawkweed, ragworts, hedge-mustard, yarrow, musk, mallow, knapweed, scabious, Canterbury bell, chicory, wild convolvulus.

August.—Hawkweed, tansy, knapweed, wild teasel.

CHAPTER XXI

THE ANIMAL LIFE OF THE HEDGEROW

The hedgerow a crowded city.—We must not suppose that our duty is done if we draw the attention of our pupils to the flora of the hedgerow. We must try to make them realise that it is not merely a glorious tangle of wild plants, but also the home of a whole world of living things. The hedgerow itself, its bank, its ditch, and the strip of grass beyond, are like the various quarters of a populous city, crowded with inhabitants of various ranks, of various habits, vestments, food, and various ways of making a living.

Its bird population.—The bird population is the more obvious and may be taken first, for the children, though they will perhaps have no notion of their numbers and variety, will often see the birds flying in and out of the bushes. In winter, as Richard Jefferies says, the hedge is an open lattice-work, but by mid-May it is filled out with a multitude of twigs and leaves, so that the nests it contains are not only guarded by thorns, but also well screened from sight. It is wonderful to note how each bird recognises the minute gap which marks the entrance to its own nest, and how it threads its way through that tangled forest without hurting its wings. "Plant hawthorn," says Jefferies, "and almost every bird will come to it, from the wood-pigeon to the wren." The children are not likely to see many varieties in one walk, or even in many walks, if numbers are together, but a preparatory visit to

the Natural History section of a local museum in the case of urban children will do much to stimulate eyesight and interest not only for school life, but during subsequent rambles. These creatures in glass cases stand for multitudes of wild things whose home is such a hedge as that by which we walk. Unfortunately school holidays nearly always come at a time when the birds have left the hedges for the reaping-fields, or are moulting in retirement. But it is by no means impossible that in the future some arrangements will be made on a large scale whereby both teachers and children will take their holidays by rotation during the summer months. For it is no longer possible for educationists to be unconcerned at the possibility of children growing up in our huge towns without any knowledge of the "real country"—a penalty too heavy to pay for the existence of our big modern industrial centres.

To return to our hedge: the familiar birds of the suburbs—the robin, blackbird, thrush—though they have other favourite nesting sites, often build in the hedgerows, and they are busy hunting along the hedge all through the summer. But *the* bird of the hedgerow is the hedge-sparrow (hedge-accentor), which is not a sparrow at all, though it is about the same size. But though it is brown above, it is bluish-grey below and on the head, and whereas the house-sparrow has a short broad bill, suitable for pecking at grain, &c., the hedge-sparrow has a slender bill, which shows it to be mainly an insect-eating bird. We see it constantly hopping on the ground along the hedge seeking for small insects. Like the robin, of which it is a cousin, it will eat anything that comes in its way during the winter, and therefore it stays with us all the year. It may be attracted to gardens by millet-seeds, of which it is specially fond.

It builds in April among the hawthorns, brambles, and hollies of the hedge, which habit has given it its name. The deserted nest may easily be found in the winter and shown to the children. It is a pretty little structure made of moss, twigs, grass blades, and fine straws bound together by cobwebs and lined with hair, feathers, and wool. It is a great attraction to birds'-nesters, and we can hardly wonder, for the clear blue of the eggs is like nothing else in the world of colour. The eggs are four to six in number, and though collecting birds' eggs is not to be encouraged as a mere recreation, it is worth while knowing that the hen will lay to replace eggs that have been removed. Tell the children how the cuckoo places her egg in the nest of the hedge-sparrow, and how the poor little hen toils to feed it when hatched; how the young cuckoo grows apace and takes up nearly all the room in the nest and far more than its share of the food brought by its foster-mother, for it is a large bird even when only half-fledged.

Other brown birds that may easily be mistaken for sparrows hop in and out of the hedge. The little blackcap differs from the sparrow in that the cock has on its head the patch of black plumage which gives him his name.

The blackcap is a very shy bird, and only builds in hedgerows that are thick and tangled. The whitethroat is somewhat like the blackcap, but, as its name tells, it has a patch of white on its throat. It makes a loose net-like nest of root fibres and horse-hair, which it likes to hide in the brambles rather than in any other kind of bush. But it will also build low down among the nettles and tangled grass at the foot of the hedge. It is sometimes called the nettle-creeper, because it is constantly searching among and around the nettles for food. In the winter both blackcaps

and whitethroats depart. "One day in the middle of September plenty of them will be seen in the hedges, and the next day not one; they have started in the night. From the tiny eggs laid in the shelter of hedge and ditch "have come the wings that are to cross the great sea."

The yellow-hammer (yellow bunting) can easily be recognised by the canary-coloured breast, golden crown, russet-brown back, and also by the continuous jerking motion of its tail.

The hen, as is so often the case, is quieter in colour than the cock, but she also has a streaky brown and yellow appearance. The yellow-hammer's song is translated by country folk as "*A little bit of bread and no cheese*," with a long drawing-out of "*che-ee-se*." Its food consists mostly of seeds, and it stays with us all the year. The nest is laid quite low down under wayside hedges, so the children can understand how desirable it is that the yellow of the mother bird should be toned down in order that she may not be seen among the brown stems and stalks. Her eggs are remarkable for the curious scribbling lines that run over them.

The chaffinch is a hedgerow bird, his call-note is "Pink! Pink-Pink!" and his song has been rendered

"Sweet, will you kiss—kiss me dear."

The cock has a blue head and a reddish-brown breast (not orange-red like the robin's), and both cock and hen have a white bar across the wings. It builds not among leaves, but in the fork of a tree or bush; if it is a holly bush, the outside of the nest is made of moss; and if in a barer situation, the bird uses cobwebs, lichen, or other material to match exactly the adjacent branches. In summer the chaffinch eats insects, and we can see him perching on a favourite bough, diving

down after an insect and then returning to the same spot.

The little brown wren, the colour of the winter hedge-bottom, builds in a mossy bank below a hedge, and she, too, chooses the outer covering of her nest to match its neighbourhood. The nest itself has a dome over it with a tiny hole at the side, and the outer walls are mossy among moss, or of dry leaves and grass if among stems and withered herbage. The cock bird amuses himself by making spare nests along the bank. If the real nest with the eggs in it is touched, the mother does not return to it, and the little creature—the “Jenny” wren of old rhymes—is so tiny, so pert-looking with her short cocked-up tail, and withal so brave and cheerful, that she should surely be spared any pangs.

Beasts of the hedge.—But beasts as well as birds haunt the hedgerow. Down at its foot are the burrows and nests of the long-tailed field or wood mouse, though sometimes, being a good climber, he may be found occupying an empty bird's-nest. Like his cousin, the house-mouse, he eats chiefly by night, and his food consists of the fruits and insects that the hedgerow provides so abundantly.

The hedge gives cover also to a very troublesome relative of his—the short-tailed meadow-mouse, or field-vole as he is sometimes called, a short thick-set little mouse who may be distinguished from the house-mouse by his stumpy tail and almost invisible ears, and whose enormous appetite for seeds, turnips, clover, and potatoes makes him the despair of farmers. These little mice have such large families and devour so much that they constitute real plagues (we read of plagues of mice in the Bible).

The red-backed meadow-mouse, or bank-vole, is about the same size as the common short-tailed meadow-mouse, but we know it by its longer tail—
Red-backed field-mouse. not so long as that of the wood-mouse—and its reddish-chestnut hair. It damages our hedge-bank by burrowing it through; sometimes it uses the burrow of a mole. While the short-tailed mouse visits the open fields, its red-backed cousin often gets its food in gardens, where it eats crocus bulbs and peas and beans.

If we find a little mouse-like creature with a very long, sharp snout, we know that it is a shrew-mouse.

Shrews. The shrew-mice, unlike the true mice, are insect feeders, and can find a good living in the hedge. There is a little water-shrew which burrows near a wet ditch and lives on water-insects, water-shrimps, and water-snails.

The mischievous mice of which we have spoken are not left to their own devices in the hedge. They are terribly hunted by the stoat—the tiger of the hedge—who is a carnivorous creature.

It looks rather like a *very* long thin kitten, for its body is extremely slender. Its fur is reddish above and white below, its tail is tipped with
The stoat. black, its neck is very long and nearly as thick as its body, and it has a flattened head that appears to poke forward. It can easily squeeze itself into a very narrow hole, in pursuit of a rabbit, rat, or mouse. It can also climb trees for eggs and young birds. Although it likes to be near cover, it is by no means timid. The writer has sat on the fallen trunk of a tree with a stoat sitting a little way off on the same trunk for some minutes, and has also seen one running along a hedge-bank on Hampstead Heath, where passers-by were frequent.

The weasel is much smaller than the stoat, redder in

colour, with no black tip to its tail. Like the stoat, it lives in the hedge, and being still thinner, it can hunt the mice in the burrows, though it will also attack rats, moles, and birds. It will chase a rabbit much larger than itself and never cease until the worn-out bunny falls a victim to its tormentor.

Nor must we forget the hedgehog, who is not a hog, but an eater of snakes, frogs, insects, worms, snails, and other small fry of the hedge, and whose appetite for insects makes him a useful house and garden pet. During the day the wild hedgehog is probably rolled up—a mere ball of spines—asleep in a hole under an old tree or stubbed bush. It is at night that he goes on his rounds and takes his meals.

Reptiles of the hedge.—In the hedge, too, we may find the slow-worm or blind-worm, as it is sometimes called. It is not blind and it is not a worm, nor even a snake, though it looks like one. It is in fact a legless lizard, and quite harmless. It may be recognised by its steely-grey back, without any distinctive markings. It is about ten or twelve inches long. The grass snake, also a harmless creature, may be seen sunning himself on a warm hedge-bank. He is longer than the blind-worm (thirty to thirty-six inches), has a yellow patch on the side of the head (the V that marks the poisonous adder is absent), and lines of golden-green markings along the side of his body.

The insect life of the hedge.—But all these creatures, birds, and beasts are a mere handful in number compared with the insect population. It is enormous beyond imagination. The nettles at the hedge-foot would be more of a forest than they are were it not that three of our most gorgeous butterflies—the red admiral, the peacock, and the small tortoise-shell—lay their eggs on the leaves of the young shoots for their caterpillars

to feed on. The eggs of the orange-tip butterfly are laid on the stalks of the hedge-mustard blossom; the painted lady prefers the thistle. The black and yellow humble-bee has burrowed a nest in the bank (or more probably appropriated the deserted nest of a mouse), and hidden it with moss which it has dragged to the entrance. Perhaps the wasp has her papery dome, well filled, in another hole. The hive-bees work over the hedge for pollen and honey. These are among the larger and more conspicuous of the insects, but it is not too much to say that almost every leaf has its inhabitant or even its colony. The pretty red-tufted "robin's pincushion" on the wild rose is the work of "gall" insects; the leaves of the brambles and hollies are tunnelled by insect miners, and the hawthorn, with which we started our study of the hedge, has no fewer than fifty-six species of visitors. Thus is a fragment

The web of life. of what Professor Arthur Thomson calls the "web of life" woven before our eyes—the mere ravellings of which we can at least show to our children to tempt them to discover more of its wonderful tracery for themselves.

CHAPTER XXII

THE PROCESSION OF INSECT LIFE. WHAT IS AN
INSECT? PET CATERPILLARS

The procession of insect life. — Richard Jefferies has pointed out that our realisation of summer being actually with us depends not on birds, flowers, or sunshine, but on the presence of insects. When their hum fills the air and their activity forces itself upon us in our outdoor walks, then it is full summer. A few insects are seen abroad in early spring when the crocus and celandine are ready, and we find hive-bees and humble-bees busy about the willow catkins as soon as the stamens are ripe enough. Thereafter comes a more and more numerous procession, the insects increasing in multitude and variety, one kind following another, and the whole army ending with the wasp, who waits until the full sweetness of the season has developed. "One swallow does not make a summer, but one wasp does." The enormous numbers and immense variety of these little creatures render it a difficult matter for even a trained adult to study entomology with any satisfactory degree of thoroughness, and we are simply bewildered when we think of insect life as a branch of Nature study for children. Yet "probably a majority of the animals now living on the surface of the globe are insects" remarks Professor Miall; and apart from their numbers, some aspects of insect life are very striking even to children. How can we set about turning their vague awareness of insects

as crawling, flying, buzzing creatures into something like real knowledge; and, more important still, how can we best touch their imagination with the suggestion of wonders yet unlearned?

What is an insect?—Children (and many adults) tend to call *all* small creatures insects. There is always a generation growing up to whom old stories are new, so the teacher may tell his pupils, with any variation of dialect he may think prudent, *Punch's* joke about the railway porter who was puzzled to know whether the rules of his company required him to insist on a tortoise being carried in the guard's van, "Cats is dogs, and rabbits is dogs, but this 'ere's an hinseck." Invite the children to qualify themselves to correct the porter's natural history. What is an insect?

Ask them to watch the house-fly, the daddy-longlegs, blue-bottle fly, the ant, the bee, the wasp (neither of the last two will sting if looked at quietly and not interfered with), any butterflies or moths, and even the domestic cockroach, often erroneously called a black-beetle. After a week or more of watching,

Observations on common insects.

devote a lesson to gathering up the results of these observations and summarising them with the help of large blackboard drawings of the creatures mentioned. Young children need to have their sense-impressions of small and complex objects heightened and exaggerated in this way. If the teacher can make impromptu drawings, adding the various parts of each insect as they are discussed, so much the better. And this is, perhaps,

Aids to future perception.

one of the not very frequent occasions when the distribution of hectograph drawings to guide future observation will be desirable. There is always a danger, of course, that children will be tempted to *think* they see what is in the drawing instead of closely examining

the real object : on the other hand, insects are so small and mobile that the attention needs some help in seizing on the important characters.

General characters.—The following points will come out : All these creatures have bodies which are jointed, and which show three main divisions. They have six legs, which are also jointed, and which are attached to the middle part of the body.

They have (generally) two pairs of wings. They show one pair of horns (antennæ) in the front of the head. (Compare with the shrimp, which has two pairs.)

Removal of common errors.—These characters will be better remembered if, after tracing them in the common insects named above and others which the children may notice of their own accord, we apply them as tests to other creatures. The spider, with its *eight* legs and no wings, is not an insect. Neither is the little grey wood-louse which is so often found under a damp stone or bit of rotten wood. It has a body covered with a kind of shell, and many legs ; it is a crustacean like a shrimp. The worm is obviously not an insect, and so on.

The above are, of course, the characters of the mature insect or *imago*. But the children have now to learn that the same insect will present a very different appearance at different stages of its career. The facts belonging to metamorphosis are best learned by keeping some form of insect as a pet and bringing it up, as the tadpoles were brought up. The teacher, while he guides this kind of observation, must keep in mind that the creature is adjusted through all these stages to the conditions of its life at the time, and must contrive to make the children realise, however faintly, that the life of an organism consists in this adjustment to its environment.

Metamorphosis of a butterfly or moth.

(1) **The egg stage.**—The insect chosen will probably be some kind of butterfly or moth. Town children usually fall back on the silkworm moth, but a very short suburban walk would procure eggs of other specimens. Perhaps the *Small Tortoiseshell* butterfly is one of the best that can be chosen. The eggs of the first brood are laid early in the year, in May, so that the butterfly emerges before the summer holidays—in June. They are laid in clusters, so that they can easily be found, and they are laid on the leaves of the nettle-plant, a troublesome weed which it is well to keep in check by breeding fresh caterpillars. The eggs are laid on the *under* surface of these leaves. Boys will no doubt like to have also specimens of the “woolly bear,” the caterpillar of the Tiger Moth. This is an accommodating creature, which though it thrives on nettles will also eat hawthorn, lime, dock, and lettuce leaves. It will be interesting to have two or three kinds of caterpillar under observation at a time, so as to compare their appearance and development.

Breeding cages.—The eggs, with a quantity of the leaves on which they were found, which will be the food-plant of the creatures later on, should be transported to a cage or terrarium. A simple and inexpensive cage, such as may be imitated by any handy boy, has been devised for use in the Whitechapel and Stepney Museums. It consists of a deep wooden tray on which is mounted a wooden framework, making the outline of a box. The sides and top of the frame are filled in with muslin, but at the front the frame is double, and a piece of glass, removable at will, is slipped in through the groove thus formed. The food-plant can have its stalks buried in a jar of wet sand or stood in a glass bottle whose opening is plugged with cotton wool to prevent the caterpillar falling in and drowning. Wrap the jar round with muslin or paper so that the caterpillar can climb up

and down easily. The floor can be left bare, or strewn with grass or leaves. In cases where the caterpillar burrows—e.g. the Goat Moth—it must be of earth.

(2) The caterpillar or "masked" stage.—From the tiny eggs hanging on the leaf a caterpillar will emerge. The wonderful thing for the children to note is that this creature is (apparently) quite unlike the insect it is to become. We may give them, as well as the word *grub* (which is commonly used for the young of flies or beetles), the word *larva*, and tell them that it means a mask. Let them see how appropriate it is. The

Comparison with worm. insect is masked by a worm-like covering, so that we actually speak of the *silkworm*—the caterpillar of a moth—and the *wireworm*, the larva of the skip-jack beetle. But provide earth-worms for comparison, and let the children note the differences. The caterpillar has only thirteen segments, and some of these segments, unlike those of the worm, bear legs. Near the head, on the second, third, and fourth segments of the body, are three pairs of legs. They are hard and shiny in appearance and they are clawed and pointed at the tips, as the hand-lens will show. These will one day be the legs of the future insects. At present they are mainly useful for steadying the leaf on which the caterpillar is feeding. After these legs comes a space, for the fifth and sixth segments have no appendages. Then come four pairs of very soft, fleshy, sucker-like legs, then another space, and finally another pair turned inwards towards each other, at the extreme end of the body. Thus our caterpillar has sixteen legs altogether, six true legs, and ten pro-legs or false legs, the last pair of which, the "claspers," are specially useful in holding on to a twig. Ten is the usual number of these supplementary legs, but some caterpillars have fewer.

The larva varies in colour according to its species.

The Small Tortoiseshell caterpillar is blackish, with long yellow stripes formed of closely-set spots. It is beset with very dark hairs. The caterpillar of the Tiger Moth is black and orange red, and its hairs are very long indeed—hence its name “woolly bear.”

The caterpillar has jaws for biting, and soon makes havoc on its food-plants, of which fresh supplies must be placed in the cage without disturbing the occupant. Its sole business at this stage is to eat, that it may grow. It grows so fast that from time to time it bursts its old skin, sheds it, and forms a new coat of a size suitable to its larger growth.

(3) The pupa or chrysalis (resting) stage.—When it has reached its full size, it ceases to eat and finds out a quiet corner in its cage. It sheds its skin once more and covers itself with a coat of a gummy substance. It then hangs itself up head downwards, by tiny hooks at the end of its tail. Some larvæ, as the silkworm, at this stage spin for themselves silken cocoons in which to rest, others draw together the edges of leaves in which to make themselves a tent (the Red Admiral does this), and some, like the Goat Moth, burrow in the earth. The caterpillar of the Large Cabbage White hangs itself up by cords spun both round its tail and also round its body, so that it lies as in a hammock. The Tiger Moth has a shiny black pupa-case which lies in its cocoon; the case of the Small Tortoiseshell is like a delicate wreathed shell. Some insects at this stage resemble miniature mummies, or tiny dolls bandaged in the swaddling clothes still worn by babies in some countries. Give the word *pupa* and connect it with the French *poupée*, a doll. The name chrysalis (from *chrysos*, gold) is so common that it must also be given. Some pupæ, of which the Small Tortoiseshell happens to be one, show golden

gleams from the skin of the insect through the pupa-case.

The pupa in a state of rest.—The children will be told that the creature is resting while changes are taking place in its body that will fit it for an insect life. Its mouth organs, for instance, are undergoing alteration so that it cannot eat; it can only lie inactive until the new ones are ready.

CHAPTER XXIII

BUTTERFLIES, MOTHS, AND THEIR CATERPILLARS

The perfect insect. Its adjustments to a new life.— If the egg of the insect pet we are watching was laid late in the year, the resting stage will last all through the winter. But in summer the warmth causes the transformation to take place in a much shorter time, and our Small Tortoiseshell which was an egg in May is a "perfect insect" by June. One morning its pupa-case will burst and there will emerge a creature apparently quite different from the caterpillar that coiled itself within the scroll-like shelter. The three pairs of legs are in the same position as the front legs of the caterpillar. At each side of the body hang a

Wings. small and crumpled pair of wings, but these gradually unfold and we see them in their full glory of colour—orange, red, and brown, with patches of yellow and black, little white spots near the outer tip of the front wings and a border of blue crescents set closely together along the margin of the side of the wings. Instead of the jaws of the caterpillar there is a long slender sucking tube or proboscis—so long, indeed,

Mouth. that when it is not in use it is carried wound up in a spiral; for the creature will henceforth live, not by biting leaves, but by sucking the juice of flowers. It will reach them, not by crawling, but by flight. Whereas it has been adjusted to a restricted and terrestrial life, seeing only a little way before it, crawling heavily over a small area, it has now a free existence

in the open, sipping honey and wheeling round and round in the air, enjoying its powers of flight.

Relation of new adjustments to future offspring.— Though some butterflies, those belonging to our Small Tortoiseshell kind included, will hibernate through the



FIG. 32.—1. TORTOISESHELL BUTTERFLY
2. At rest. 3. Chrysalis.

winter, the life of^o these creatures is generally very short. The female soon seeks out some place on which to lay her eggs. This is her purpose in life, and it is for this that she has a light body, nourished by light and dainty

food, and borne by swift wings. For if she had to remain on her food plant as a caterpillar, she could crawl a short distance only, and the race of butterflies would soon die of starvation, for the caterpillars produced are so numerous that they would speedily exhaust their patch of food-plant. But now she can fly to some distance and start her little colony in a fresh feeding ground. How she knows on which plants to leave the eggs, and how she knows that the under side will better screen them from the sharp eyes of devouring birds, is a mystery, but it is certain that she does not make a mistake.

The ethics of butterfly hunting.—When the children have watched the transformation of a butterfly through the stages of egg, larva, pupa and perfect insect, they will be keenly on the look-out for other butterflies, especially in their active stages of caterpillar and insect. Books on the subject, even when written for young children, contain somewhat too much about cyanide bottles, pins, and corks. Nature study is now a popular subject and is taken in nearly all schools, and it is certain that if it results in this kind of activity on any large scale we shall soon be in danger of a serious depletion of our rarer butterflies as well as of our rarer flowers. It is a far better thing in most cases to utilise the collecting instinct in hunting for eggs, larvæ, or pupæ in order to add to the beauty of the summer by breeding them into perfect butterflies. But destructive larvæ, like those of the large Cabbage White butterfly and Codlin moth, should be dealt with differently in their earlier stages, for they diminish the supply of human food. Dr. Hodge, in his suggestive book, "Nature Study and Life," considers very wisely and temperately the problems of when to repress and when to diminish the lower forms of life. He urges that beautiful forms should be helped to increase

and multiply, as adding to the good of human life. But to destructive insects, from which America suffers

even more than England, he applies the precept of Genesis, "Subdue the earth." **Opposed ideals.**

These creatures, whose numbers make them so formidable, are in warfare with men. It has been calculated that one Cabbage White butterfly will lay enough eggs at the beginning of one summer to produce more than one and a half millions of offspring by the end of the next season, and our kitchen gardens must suffer enormously from these greenish-yellow caterpillars, even though a large proportion are devoured by birds. Such "pests," as they are called, must be fought against by grown-up people, preferably by Nature's own methods of fostering those birds and other creatures such as toads, hedgehogs, blindworms, &c., which use insects as food, but also by prevention and extermination in their earlier stages. Elder children who undertake gardening must perforce take part in this kind of work, but not before some sense of responsibility and power to look upon the web of life as a *whole* has been developed. And no small part of the value of Nature study, by-the-bye, lies in its tendency to improve that discrimination between harmful and harmless or useful creatures which is often so strangely lacking even in persons who have spent all their lives on the soil.

Lepidoptera, or scaly-winged insects.—The beauty and size of butterflies and moths will probably make them the most interesting of outdoor insects, even if their larvæ have not been kept as pets. Children will ask questions about their beautifully coloured wings. An accident will probably make them aware that the wings are covered with a kind of fine dust. The microscope only can give a full revelation of the minute scales which are so marvellously fitted together to make the colouring of these mobile flowers, as they

seem to be. "There is scarcely any colour which cannot be matched in the gay world of wings."

Distinctions between butterfly and moth.—The distinctions between a moth and a butterfly will next be noticed. The children will find that a moth has a thicker and more hairy body. Whereas the long antennæ of the butterfly end in knobs, those of the moth are toothed and fringed. They will find that butterflies love the light and sunshine and will fold themselves to rest when a cloud passes over the blue sky in the daytime, whereas the moths are generally seen in the evening and in duller weather. When a butterfly is at rest, its wings are brought together in a vertical position, so that they appear to stand up over its back, and the upper surface is hidden. Suggest to them to notice how a butterfly such as the Small Tortoiseshell is able to "hide" in this way, for the quieter colouring of the under surface of the wings is so dun and inconspicuous that the creature looks like a bit of dead leaf. When a moth is resting, on the other hand, its wings will be held horizontally over its body, the upper pair generally covering the lower pair or a large portion of them, so that the creature forms a triangular figure. As a rule, too, the moth is quieter in colouring than the butterfly, though this is not always the case, as witness the orange-scarlet hind wings, richly spotted with purple, displayed by the Tiger Moth.

Let the children note in their air calendars the date on which they see any particular moth or butterfly, for these, like flowers and birds, have their own special times of appearing. The "early" butterflies, such as the Small Tortoiseshell and the Orange-tip, have hibernated through the winter; they are really the "late" butterflies of last season. Fortunately some of the most beautiful, such as would be most likely to attract children, are also the most abundant. The Red Admiral.

the Peacock, the Painted Lady, the Brimstones, the Blues, among butterflies, and the Tiger, Lime Hawk, Brindled Beauty and Swallow-tail moths are all easily observed.

Caterpillars and their ways.—If the butterflies are watched because of their beauty, the caterpillars will be studied because of the "quaintness" of their behaviour. Children are specially delighted to watch the larvæ of the "geometer" moths, so called because they seem to measure the ground over which they travel. They like to watch them moving, making a high narrow arch or *loop* of the body between the two sets of legs as they cover the ground, whence they are also called "loopers." Sometimes they will hold on by their claspers to a twig while the rest of the body sways about in the air like a waving stick. Sitting under a tree, we are often startled by seeing one of these "looper" caterpillars letting itself down by a silken thread which it has spun out of its body to serve as a rope. Others, again, hold themselves out stiffly at an angle from the twig to which they are clinging by their claspers so as to look exactly like a bit of the twig itself.

Colours and hairs of caterpillars.—Some caterpillars are protectively coloured, green on green leaves, dark brown on bark, &c. The pupæ are nearly always concealed in this way. Some, again, are coloured and covered, not to hide from their enemies, but to terrify them. The "woolly bear," the caterpillar of the Tiger Moth, is a fearsome-looking creature, with long hairs which would be very irritating to the throat of a bird who tried to swallow it. Consequently a bird, having made one attempt, avoids all "woolly bears" in future; thus the first victim saves the lives of his brothers.

Moreover, a caterpillar, as may be seen in the breeding-cage, will often roll to the ground. When

doing^o so, he coils himself up into a ball, and the long spines break the shock of his fall. The Small Tortoiseshell shows the same sort of contrivance, though it is not so "sensational" a creature as the woolly bear.

The caterpillar of the Elephant Hawk Moth has two great marks on the head, which, though the creature is quite harmless, are very alarming to birds. They have been known to fly away from a tray of favourite seed on which one of these was placed. The Puss Moth caterpillar, besides reddish-coloured patches on its head, has a way of rearing up the front part of its body, and also flourishes a forked tail to frighten its would-be consumers.

CHAPTER XXIV

SOME FAMILIAR INSECTS

Two-winged insects: flies.—Though we talk of the butter-fly, the dragon-fly, the turnip-fly (a small beetle), all these creatures belong to different orders of insects, and the word “fly” is properly applied to a *two-winged* insect. To this class—the *Diptera*—belong the house-fly, the daddy-longlegs, the bluebottle-fly, the gnat, midge, and mosquito, to mention only those that are likely to be familiar to children. Watching the “busy, thirsty, curious” house-fly, the children will find that it has only two wings. But with the help of the hand-lens they may make out that its relative the daddy-longlegs has in place of the second pair of wings a pair of little knobs mounted on a short stalk, one on either side of the body. These serve to balance the creature when flying, so as to keep it in the right direction. The house-fly has similar “balancers,” which, however, the children will hardly be able to observe. If they ask how it is that the fly is able to walk on the ceiling with its head and back downwards, they can be told that it has little hairy pads on the underside of its feet, and that these secrete a sticky substance, which enables it to glue itself, as it were, while walking, though not so firmly as to resist a pull as it proceeds.

The larvæ of flies are not like caterpillars; they are small, footless creatures which are called “maggots.”

The Nature study here may be made to contribute to domestic hygiene. The house-fly, though it comes to

the house for food and shelter, is not bred in the house ; but in horse manure and similar filth, and it breeds very abundantly. "One fly has been known to deposit forty-five eggs in a single night, and probably lays a thousand during her life. In about fourteen days these will be full grown, and a fresh generation will be produced." There is no doubt that though flies may, to a certain extent, act as scavengers, they also carry disease germs. The bite of many kinds of flies is dangerous as well as tormenting to men or to animals. Malarial fever has been reduced in certain districts by draining the swamps where mosquitoes were bred. The inference is that no possible breeding-grounds should be left near human homes.

Beetles: sheath-winged insects. Beetles belong to another order of insects, *Coleoptera*, or sheath-winged. They have four wings, but the front pair have become thickened into horny sheaths called wing-cases, and the hinder pair are folded away within these. The beetles, therefore, fly rather heavily. The larva of a beetle is called a "grub," though the word is sometimes applied to the larvæ of other insects. A beetle eats solid food all its life, and therefore has not a slender sucking tube like the butterfly, but a pair of stout jaws.

Boys will know the stag-beetle and the cockchafer, but the ladybird will probably be the favourite beetle of most children. They will find ladybirds abundantly on the leaves of rose-trees and other garden plants. They do not eat the leaves, however ; on the contrary, they should be very welcome visitors, for they live on the tiny soft green "flies" or aphides—"blight" as they are called—which do so much damage by sucking the juices of the green tissues of the plant. These insects are also utilised by some ants, who milk them, as we milk cows, to draw from them a sweet juice, called honey-dew, which they secrete. (This must not be

confused with the honey made by bees.) We find honey-dew dropping upon us from blossoming lime and sycamore trees, for these little creatures infest trees as well as lowlier plants. Now the larva of the lady-bird, which hatches out from a tiny orange-coloured egg laid on the underside of garden leaves, is not a vegetable feeder like the caterpillars, but is an insectivorous creature from the beginning; it is obvious, therefore, that it is an extremely useful friend to the gardener.

Bees, wasps, and ants.—The bees, wasps, and ants belong to the class of membrane-winged insects (*Hymenoptera*), though other insects, such as the dragon-fly, also have wings of this kind. It is very difficult to recognise the various kinds of *Hymenoptera*, for, to take one class only, there are no fewer than 250 species of *wild* bees. Many stingless insects, again, simulate the shape and bright colour of the wasp in order to be avoided by birds, who, taking them for wasps, will be afraid of the sting. But all children should at least be

Distinctions.

able to tell a wasp from a bee by its longer body with black and yellow stripes and very slender "waist." And they should be able to distinguish a "humble" (or "bumble") bee from a hive-bee by its *humming* or *booming* noise (whence its name),



FIG. 33.—WASPS.
1. MALE 2. FEMALE 3. WORKER

its larger size, its rich colouring, its more hairy body, and its lower, heavier flight. They will like to know how

the humble-bee makes a nest for itself in a hole in the ground or in the deserted nest of a mouse, low down among the fibrous roots of the meadow grass or in a hedge.

The hive-bee.—Volumes have been written on the history of the hive-bee, and in this series of suggestions one can only urge upon teachers to try to procure an "observation-hive," or to take the pupils to see one. Otherwise, it is very difficult for them to follow verbal descriptions of the arrangements and economy of the hive. Something may be done by setting the children to watch the entrance of an ordinary hive, and when we consider that a hive of bees flourishes in a recreation ground in Whitechapel, this should not be impossible in any district. The business of the workers in gathering pollen and honey out of doors may also be fairly well observed, and some details must be filled in by the teacher as questions arise, or as the "observation-hive" supplements what has been noticed in the open.

The duties of a "worker" bee.—The workers are smaller than either the queen or the drones. The children can see that they are busy from the first fine days of the year in gathering pollen. The yellow dust of the pollen is stroked or brushed from the anthers, and also falls on the fine hairs of their bodies and on their legs. It is brushed away, collected, and stored in little spoon-shaped hollows on their hind legs, which are guarded by bristles. The pollen is used as food for the young at home in the hive, for the bees in this respect are more advanced than the butterflies and moths, who merely place the egg on a food-plant and leave it to feed itself. The queen bee has laid her eggs in some of the wonderful six-sided cells made of wax which the workers form for their reception. The wax is not obtained directly from the flowers, but from glands

**Collecting
pollen.**

between the segments of the abdomen of the worker. The eggs are hatched, and certain of the workers feed the young larvæ with a pollen mixture for ten days. Then they seal up the cell. This feeding period corresponds to the caterpillar stage in the case of a moth or butterfly. Within the sealed cell the larva goes through its pupa stage, and then emerges as a bee.

**Making
wax.**

QUEEN



WORKER



DRONE



FIG. 34.—BEES

Other of the waxen cells are intended to store honey for the winter, when there will be no flowers to yield

any. Accordingly, the workers collect the honey. This they do by means of a long tubular tongue which sucks up the sweet juice from the flowers which contain it. The early spring flowers give more pollen than honey; but this is what is needed by the nurses for their larvæ. When the fruit blossoms come, honey storage begins in earnest. The hive has undergone a "spring clean" by its busy inhabitants, who have turned out all dust, refuse, dead bees, &c., and the keeper can put in his "frames," knowing that the cleanly little insects will fill them with pure, sweet honey.

When the hive becomes overcrowded, which happens in late spring, the queen bee, who is the mother of them all, starts a fresh colony. She takes with her some of the bees, who surround her closely and take the greatest care of her, and sets out with her "swarm" to find a new hive. People who keep bees are on the look-out for this exodus, and sometimes catch the queen bee and place her in another hive, where a large number of the workers always follow. If this is not done, the queen may lead the way to a hollow tree or some other inconvenient place. If the swarming takes place fairly early in the year, the bees will settle down to work and fill their combs satisfactorily by the end of the summer. Hence

A swarm of bees in May is worth a load of hay,
 A swarm of bees in June is worth a silver spoon,
 A swarm of bees in July is not worth a fly.

The taste of the honey depends upon the kind of food the bees get. White clover furnishes a specially choice form of honey; but "heather honey" is still more valuable. Bee-keepers living within a possible distance of moorland country sometimes take their hives thither in August in order to let their bees suck the innumerable

heather bells. The prudent bee-keeper, in taking honey from the hives, takes care to leave enough for the inhabitants of the hive to last them through the winter—with a little artificial feeding of syrup towards the end. The supplies last all the longer from the fact that the drones are turned out in the autumn to perish.

Ants and their ways.—The economy of an ant-hill is even more wonderful, and an artificial ants' nest is easily constructed with a zinc tray, some earth, and two panes of glass, the upper pane resting on a frame of wood. Here the children may see the queen ant, the mother of the clan, surrounded by the wingless workers, who place her tiny eggs in nurseries. Here the eggs pass through the various stages of insect life. As larvae they are fed by their nurses, and when full grown they



FIG. 35.—THE HORSE ANT, male, female, and worker
Natural size and magnified

spin for themselves their cocoons, so often erroneously called "ants' eggs." When the time arrives for the insect to emerge, the workers help it to find its way through the cocoon by opening it from without. Some ants, as we have said, will keep "cows"—the little juicy "aphides," whom they "milk" for the sweet liquid, the honeydew, which they secrete.

Some of the ways of ants may be watched out of

doors, in their homes beneath stones or fallen bark, or in their domes of pine needles; though the children will be likely to see only the wingless workers. But they can see how the ants live in communities, how they make underground cities and roads, and, more wonderful still, how they seem to communicate with one another by their antennæ and co-operate in carrying burdens and tending wounded friends. Tell the children that ants are the most intelligent of all known creatures, man excepted; read to them or tell them of Lord Avebury's experiments and observations, and thereby stimulate, perhaps, some entomologist of the future; while giving to the rank and file a deeper sense of that Intelligence which works not only *above*, but also *in* the mystery of life.

CHAPTER XXV

FLOWERS AND THEIR ADJUSTMENT TO INSECTS (I)

The meaning of flower-markings.—During the summer even those teachers who have not “specialised” in flowers will find their pupils bringing in flowers for decoration and for the ten minutes’ Nature talk which we have supposed to be given each day for this kind of work. Now, it is quite possible, of course, to regard each flower, with its shape, colour, and markings, simply as a beautiful object whose characteristics merely serve for purposes of recognition. This was the manner in which flowers were regarded even by interested people until the end of the eighteenth century, when a German pastor, Christian Sprengel, discovered that their varied forms and markings were not merely arbitrary embellishments, but were designed to catch the eyes of insects. There is no reason why the modern child should not be led almost from the first to enter into the delight of this discovery; for the discernment of *purpose* and *fitness* in beautiful objects is an added exhilaration to the merely æsthetic appreciation of them.

Clues to the behaviour of flowers.—Let the children, therefore, watch the behaviour of insects in regard to the flowers in the school garden or in the hedgerow, and without striving either for the laborious inductions by which some teachers try to urge their pupils to become Sprengels or Darwins while still in pinafores, or without “dumping” down upon them information of a

tipped with crimson, of the daisy, the rich browns and yellows of the nasturtium and wallflower, the beautiful combinations of gold and purple in the pansy, the orange rim of the crown of narcissus, the golden circlet round the throat of the blue forget-me-not, are among familiar instances of contrasts designed not primarily, perhaps, to please the eyes of human beings, though we gratefully accept the feast of beauty thus offered, but to suit the eyes of insects, who apparently have the same taste for colour as ourselves.

And, in connection with schemes of colour, we may note how some of the colour is concentrated, as it were, in blotches or lines, so as to show the insects what is the precise whereabouts of the treasure it is seeking. The guiding lines of the crocus, meadow-geranium, mallow, laburnum, and pansy, for instance, point straight to the mouth of the tube where the honey is concealed, and the "little speedwell's darling blue" is seamed by white lines to catch the eye of the insect flying low along the hedge. The blossoms of the horse-chestnut, which stand up in June like candles on a Christmas-tree, are beautifully flecked with pink. And the "dappled" foxglove, a flower always delightful to children, has blotches on its lower lip which catch the eye of the humble-bee flying heavily through the copse or along the hedgerow.

CHAPTER XXVI

FLOWERS AND THEIR ADJUSTMENT TO INSECTS (2)

Adjustments in the shape of flowers.—Certain flowers are adapted for certain types of insects. Those that suck honey are mainly butterflies and moths, bees and flies (*Diptera*). The ivy and the red-currant each has a cushion of tissue on the top of its seed-vessel, and the honey glitters there in profusion. This cannot be eaten by insects with a *long* sucking-tube, such as butterflies or humble-bees, who would have the same difficulty as the stork in the fable to whom the fox offered food in a shallow dish, but it is greedily sucked up by small flies, who have *short* sucking-tubes. But in other cases the honey is placed where it can only be reached by insects with a *long* sucking organ. Thus the common nasturtium makes a spur of its calyx in which to hold the honey. In the pansy one petal is modified for the same purpose, and in the columbine each of the five petals is a honey-tube. The campion and the forget-me-not keep their honey in tubes with narrow throats. White clover is haunted by hive-bees, but only humble-bees, with their very long tubes, can reach the honey in red clover. The old puzzle about the connection between old ladies' cats and red-clover crops may be set. Cats eat mice—field-mice as well as house-mice—and field-mice destroy the nests and combs of humble-bees, and if there were no humble-bees to carry the pollen, the red clover would probably have to be

comprehensive character which they cannot apply, let the teacher give hints, suggest little "problems" or questions, and (better still) encourage the spontaneous questions of the children; let her invite comparisons between one flower and another, or between different stages of the same flower, and let her show how one bit of knowledge fits into another, and interprets fresh cases. For example, children know that plants produce pollen on their anthers, and from what they have been told and from their own observation they know that insects eat pollen; moreover, bees feed their young upon it. A bit of sheer "information" must be added to supply the key to a whole host of interesting facts, and the children must be told that it behoves the flowers to have their pollen removed, not, indeed, that it may be eaten, but that it may be carried to other flowers of the same kind, and there help to produce seed that will ripen and by-and-by germinate. As a rule, the plants produced by pollen that has been brought from other plants are finer than those which are self-fertilised, as it is called.

Carriage of pollen.—This gives a clue along which an intelligent child may feel its way to fresh discoveries which will give him that sense of delight in *adjustment* which is one of our keenest mental pleasures. We have supposed him to have noted that in the case of many catkins borne on trees the *wind* was the carrier of pollen (*vide* Chapter XV). But in the case of showy or scented flowers the plants trust to the various kinds of insects to remove the pollen from one flower to another. If a shoot of an insect-fertilised plant—the sweet-pea, for instance—be enclosed in a thin muslin bag or "sleeve" so that no insects can get at the blossoms, it may very probably happen that no seed is formed in the seed-vessels at all.

Children hear a great deal about insects visiting

flowers for honey. They should realise that the concern of the *plant* is with its pollen, and that honey is only a by-product. Some flowers produce pollen only, and no honey at all. This is the case with the wood anemone, clematis, rose, poppy, and St. John's wort. If the children bring these flowers, let them notice that they are round and cup-like in shape, not irregular like the larkspur or honeysuckle. They have *many* stamens, and produce a large quantity of pollen, whereas the dead-nettle, for instance, has only four stamens. In the midst of each of the flowers we have named there is a tuft or bush of stamens, and within them a convenient platform, such as is afforded by the top of the seed-box in the poppy, on which the insect may alight.

When the insect turns itself round among the stamens in order to get at the pollen, it must happen, even apart from its purposive brushing and stroking movements, that it is well dusted with the yellow powder so profusely shed by the anthers. If a child will stand quite near the flower he can see this for himself. When the insect goes to another flower, so much pollen has, and shed in apparent waste over its body that it, and inevitably brush off some of this pollen on the next, of the second flower, and thus, by manifold little for ~~deeds of~~ this kind, the purpose of this species of is achieved.

Honey, a by-product; a bribe.—To secure daisy, carriage of pollen, especially when it is not very dant, plants will offer inducements to insects observed and than them. This is the real meaning of chances of which *many* flowers produce. Nearly all *insectifera*, honey *in* bees, as we know, store it for the food. *done* plant produces it, therefore, in, as they bribe insects to settle on it, and thereby *re*our-con-pollen. Thus the buttercup provides honey sometimes

abandoned as a crop for fodder, for no seeds would be set.

This adaptation in the shape of certain flowers in order to attract a certain type of insect is specially seen in flowers that do not produce very large quantities of pollen, and cannot therefore afford to have their honey taken by insects who perhaps would not carry away what pollen there is. These flowers seem almost to belong to those intelligent insects who, besides being hardworking, are clever enough to be aware of what is being done for them.

The flowers of the sweet-pea, for example, are so arranged as to attract bees. Besides the beautiful colour scheme, the children should be led to notice the shape of the flower. An upright "standard," which would well advertise a single blossom even were it not, as is the case, grouped fairly close to others on a little branch, two petals which stand out as "wings," and two more which are joined together to form something like the "keel" of a boat, make up the five petals of the flower. The honey-bee, seeing this lifted mass of colour in the "standard," naturally flies to it, and finds a platform to alight upon in front of it. The weight of her body as she settles on the wings presses down the keel, for wings and keel are locked together. But within the keel are the stamens, and as the keel is forced down, the anthers shed their pollen on the under side of the bee while she is searching for honey in the long stamens-tube. An insect who has not a fairly heavy body would not be able to accomplish all this. Let the children watch the process for themselves, standing quite still so as not to disturb the visitor, and also they may try to produce the same result with a bristle from a pastebrush.

The dappled foxglove is specially contrived for

humble-bees. The whole plant is most interesting. In July the children may note how its long flower-stalk lifts aloft the button-like buds, which are now erect. But when the bells open they hang downwards, not only to protect the pollen from rain, but also to keep out small crawling insects. The foxglove, which grows in clear spaces in woods or on hedgebanks, turns all its open bells towards the bright sunlit meadow or glade where the bees are flying, and the specks or blotches on its lower lip catch the insect's eye. There are four stamens, two of which ripen before the others, and the stigma does not ripen until the pollen has been shed, so that the plant cannot be self-fertilised. The loose pollen is prevented from falling out by tufts of hairs near the mouth of the bell. These hairs are likewise a palisade against small insects who may have flown in or successfully rounded the curve of the bell. The shape of the foxglove fits like a glove, not, indeed, over the paw of the fox, but over the whole body of the humble-bee, who fills it entirely as he searches for honey, and cannot help being dusted by the stamens above and by the loose pollen below. The humble-bee and the foxglove are perfectly adjusted one to another, and one may catch a humble-bee by closing the mouth of the sack formed by the flower.

The snapdragon, a relation of the foxglove, has a lower lip firmly closed over the tube which holds the honey. Only the humble-bee seems to have sufficient weight to press down the lip and get at the honey, though other bees sometimes try and succeed. The calceolaria, another relation, which grows in suburban gardens, conceals its honey in a golden purse, which "snaps" or gives way in the same fashion as the snapdragon lip, returning to its position when the visitor has departed.

**Relations
of the
foxglove.**

In taking the honey as from a spoon from the nectary within the purse, the bee's back comes in contact with the overarching anthers, and the pollen is shed out of it. The purse, of course, does not give way to the pressure of small insignificant insects, whose backs would not brush the anthers.

The white dead-nettle is yet another flower which is meant for humble-bees. This is a very common flower, no relation, of course, to the stinging-nettle, though its leaves are similar, but a labiate, or *lip*ped flower. Above the lip the upper part of the flower makes a hood to shield the anthers from rain. "Little old man sitting up in



FIG. 36.—DEAD-NETTLE

bed" some country children call them as they show under the hood. The stigma is close to the anthers, and the hood arches over it so as to keep it low enough

to be brushed by the bee's head with pollen which it has brought from another flower.

Smaller bees, such as the hive-bee, can easily reach the honey of such flowers as orchard blossoms, of lime-trees, of white clover, and of heather, the length of their sucking-tubes being just proportioned to the flower-tube in each case.

Flowers
visited by
smaller
bees ;

Butterflies have very long sucking-tubes, and will visit any flower that is large and coloured enough to attract them, and which provides a tube for them to explore and a platform to rest upon. The ragged-robin and the campions are familiar examples.

Small flies and beetles, as we have said, like expanded flowers in which the pollen or honey is easily obtained, such as buttercups and umbelliferous plants. The honeysuckle tube, on the other hand, is so long that not even the proboscis of a bee can reach far enough down, and it is specially visited by large moths.

It must not be overlooked that some flowers seem extremely hospitable to all kinds of insects. Thus, Scott-Elliot, following Müller, a German investigator, states that the dandelion has ninety-three different species of visitors, and the bramble-blossom has sixty-seven.

by many
kinds ;

Devices for exclusion.—If there are devices for attraction, there are also devices for exclusion of unwanted insects, who steal honey without transporting pollen. We may mention the slippery stem and recurved bells of the "wild hyacinth," the narrowed tubes, guarded by scales, of the forget-me-not and campion, the hairy stem and lobster-pot arrangement of the sepals of the bulbous buttercup, and the formidable

bristling palisade afforded by the stout bracts or "involucre" of the cornflower.

Special devices of the orchis.—The orchis is a common meadow flower which is always a delight to children for the wonderful contrivance which it shows for securing profit from the visits of insects. There is a spotted lip-like petal which hangs down in front of an open throat of the flower-tube. Instead of the rings or single threads of stamens commonly found, they see only a kind of beak under a hood surmounting the open throat. If they touch the base of this beak carefully with the tip of a pencil, they will carry away on its tip two little clubs, which stand upright from the pencil, to which they are glued by a sticky substance. These clubs are masses of pollen. If the pencil be watched, the two little clubs, which at first stood upright, now begin to fall forwards, so that they lie in a line with the straw. If the child pretends that he is a bee who is looking for honey in the long spur below the throat of another orchis-flower, he will see that the two little clubs must come in contact with a sticky hollow—the stigma—just *under* the beak, at the mouth of the tube. So the orchis arranges that the bee shall carry the pollen on its head for just about the time it would take to reach another blossom. By that time it will have sunk to the precise position in which it can be caught on the stigma of the second flower.

Floral enigmas.—It will be seen that every flower which the children can find in garden or field or hedge has its own adjustments. No doubt the teacher will very often have to say "I don't know" to the questions put by the children with regard to this or that peculiarity, but in a subject like Nature study it is specially valuable to the pupils to learn that a whole world of inexhaustible wonder as well as of beauty lies before grown-up people as well as themselves, and that some

questions cannot be answered, although the attempt to solve them never ceases to fascinate. Besides awaking the

Collecting flowers. inquiring instinct, this study of flowers leads to the exercise of the collecting instinct.

Here we may say that the best way of "collecting" flowers is to *grow* them, and the school flower-show should help to foster this. Prizes for bunches of wild flowers should not, in our opinion, be offered. In Sydney, where Nature study is carried on in an enlightened manner by educational authorities anxious to preserve the natural beauties of the neighbourhood for posterity, collections of wild flowers, equally with specimens of birds' eggs, are excluded from school exhibits. The temptation is strong to produce trophies of "rare" specimens, and if this be induced in a whole population of school children the results on the rarer flora are disastrous. The collecting instinct must be kept in moderation. When the pupils are old enough to need a collection for purposes of class reference, the specimens can be dried by placing them very carefully in dry sand, or, if this is not available, between sheets of newspaper frequently and carefully changed and kept under pressure. But such specimens inevitably fade, and scantily suggest the grace

Records in brushwork. and colour of the living plant. It is better, we think, to train children to use the brush as a means of expression, so that when a

plant interests they may paint it as accurately as possible from Nature. The herbarium specimen, dried, flattened, and decolorised, is forgotten, but the effort of painting secures a more vivid memory-image of the plant, round which will be associated not only its adaptations to insects, but gradually, as knowledge widens, its relationships in the scheme of plant life, its nutritive, healing, or poisonous properties, its folklore, its place in literature. And the habit of portraying flowers in all the beauty

of their exquisite poise and fresh colour is no small gain. There is no reason why many school children, even of a humble class, should not afterwards experience in some measure that kind of delight, at once creative and appreciative, which is depicted by Miss North in her "Recollections of a Happy Life," and there is no reason why a portfolio of flower studies, collected from a narrower area, but as sincere and individual in their way as her flower portraits at Kew, should not be found as a frequent family treasure.

CHAPTER XXVII

THE GRASS OF THE FIELD

At the end of June in the southern counties of England, and somewhat later in the north, the air is filled with the scent of new-mown hay. In the weeks just before mowing, when the children see the grass lengthening in the fields, they may learn something about this universal garment of the earth. This is well worth while for the mere beauty of these "soft, countless, peaceful spears," as Ruskin calls the grass stalks. Besides this, grasses are of great importance. Professor Marshall Ward says: "It is perhaps not too much to say that if every other species of plant were displaced by grasses of all kinds, man would still be able to supply his chief needs from them." To English children the "grass of the field" means the grasses grown in some fields for *pastures*, where cattle may graze, and in other fields (*meadows*) where the grasses are mown and stored for winter use. Let them examine a patch of pasture and the edge of a meadow just before mowing. Sow some of the commonest grasses in the school playing-field. In rural districts these may be differentiated according to their fitness for meadow or pasture respectively, and useful, useless, and injurious grasses may be recognised. The names of some of these grasses, cock's-comb, cat's-tail, fox-tail, &c., are attractive to children, and they will be

pleased to make a collection and find out why the names are appropriate.

Roots.—The children will find how difficult it is to draw up a complete plant from the soil without breaking its roots. These are very thin and fibrous, all starting from the same point (cf. seedling wheat, Chapter XIII). No part of them is thicker than another, and they can penetrate easily into the soil, firmly holding on to it and reaching a long way down in a close network. In some places on the sea-coast the children will be able to see how the roots of a coarse grass bind together the loose sand of the low hillocks along the shore.

Stems: running or tufted.—The stem of a grass needs to be carefully looked at. What we call the stem is not really such, but rather a stalk which is meant to flower, and which is called a haulm. In some grasses the true stems creep or run along the ground and strike down a new set of roots from each knot as they run, much in the same manner as the strawberry, a plant in which the children will be interested at much the same time of year. But whereas the strawberry "runner" is above ground, in many grasses the stems creep underground, as in the coarse "bent" grasses of the sand-hills. Sometimes, however, the stem does not creep at all, but remains very short and sends up branches from a point quite close to the ground; these are *tufted* grasses.

Grass leaves.—Both the stems and the flower-stalks consist of tubes placed end to end and divided into sections by knots; when the grasses are ripe, these tubes are hollow. Both the hollow sections and the knots can be well seen in the big grasses, such as wheat, and in the bamboo rods which enter so much into modern house furnishings. In the growing grasses of the meadows we never see the stalk except the top joint, for it is so completely hidden by the leaf. Let

the children trace down a blade or leaf of grass to where it seems to join on to the stalk. It is not joined there, but is found lower down still, much wider, but wrapping the stalk round in a sheath between one knot and the next below. The edges of the sheath meet on the side



FIG. 37.—RYE GRASS

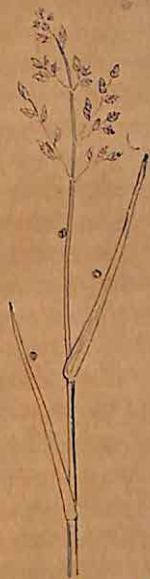


FIG. 38.—POA ANNUA

of the stalk opposite to the blade so as to form a kind of tube. Where the blade broadens out into the sheath at a knot there is a small whitish strap (ligule) which the children can quite well make out. At the lowest part

of the stalk only one sheath is seen, overlapping those within. The blade itself is very long and ribbon-like, but with veins and ribs that give it strength running lengthwise to the tip. Ruskin describes a grass blade as a "narrow sword-shaped strip of fluted green." Let the teacher give a clear idea of the whole arrangement of haulm, sheath, ligule, and blade by letting the children reproduce it in a paper model. Ruskin's own suggestions, given in his "Proserpina," will be found very helpful in this bit of work.

Flower-heads.—The children will not realise that grasses have flowers until the flower-stalks lengthen out above the blades, which they do as summer advances. While they are weak, so that they might be damaged by the high winds, they keep close to the earth. In pastures and lawns where the grass is kept constantly cropped or cut, the "goodness" of the plant goes to the making of fresh leaves, but in meadows the flower-stalks lift upwards and the children may see in June the inflorescences or spikelets hanging out tassels which they will recognise to be stamens. And since oats and wheat are big grasses, have some specimens of these grown for the purpose of comparison. In the oats they will see a central stalk with branches which again branch, so that the flowers and afterwards the fruit hang out loosely. In the wheat, on the other hand, the little flowers cling quite close to the branch in rows, so as to form an ear. In the meadow grasses they will find both types of inflorescence repeated. The rye grass and fox-tail have close flowers like the wheat, and there is a wild oat-grass which imitates its namesake. The common meadow grass, *Poa annua*, which grows everywhere, hangs out its flowers quite loosely from the stalk.

Flowers.—Grasses do not develop showy floral coverings. The true flowers are protected by scales, and sometimes by bristles, e.g. the "awn" of oats, of the bearded wheat, and of barley. The flowers of grass

are very small, but those of wheat can be made out with a hand-lens and the children will be delighted to see the two feathery stigmas and the three dangling stamens. Afterwards they will be able to find these in a cat's-tail or fox-tail, for instance.

Pollen carried by wind—They will easily see that the humblest grasses, like so many great trees, depend on the wind to carry their pollen. The pollen of the high trees was shaken out by the March winds that it might travel far; the pollen of these grasses is gently wafted by the light breezes of summer, for its fellow-plants are quite near. All the grasses have to do is to bend lightly to the wind on their slender but strong and elastic stalks, the hollow tubes admirably adjusted to the strain they have to bear, and to "softly brush each other with their flossy heads." Some of the pollen must inevitably fall on the feathery stigmas quite near them. Indeed, when pollen is ripe it is so abundant that one sees it blowing across the meadow like smoke, and sometimes people suffer from hay fever by breathing it into their nostrils.

Hay-making.—Grasses should be cut for hay just before the time that the pollen can be shaken out of them, and obviously before they run to seed, for the object of cutting is to secure the nutritious parts of the sap, which would otherwise pass upwards to the seed. The surplus water is to be dried out of the mown grass, and for this it must be tossed and turned. The scent of the hayfield is due to one special grass—the sweet-scented vernal grass, which is one of the first to bloom and which is greatly liked by animals.

Clover crops.—Not only grasses but clovers afford hay crops for fodder. We have already spoken of the red and the white clover fertilised by the humble and hive bees respectively. Children will find much besides to note in clover. It is very interesting to see how the little flowers that compose the "head" of the

clover behave. The flowers at the bottom of the bunch open first, and when the pollen has been taken away they droop down, so that the bee knows it need not waste time in searching them. Let the children notice how the clover leaf when it happens to be competing with grass in a meadow, brings up its pretty threefold leaflet as high as it can to get air and light. These leaflets sleep at night. The two leaflets at the side fold their dark-green faces together as children fold their hands, and the leaflet at the top turns over so as to make a tent above the other two. The clover may be "put to sleep" in the day time by covering it with a flower-pot. Let the children cut out clover leaves in paper and arrange them in both sleeping and waking positions.

"Weeds" of the meadow.—Notice how the "weeds" which intrude among the grasses push *up* their leaves to compete for light and air with the closely-set blades and flower-stalks. A dandelion growing by the path will "sprawl" its rosette of leaves on the ground; in the field it thrusts them upwards. Meadow weeds produce either long grasslike leaves or leaves that are narrow and much serrated. Let the child look for the buttercup, the plantain, sorrel, ox-eyed daisy, yellow rattle, and pale mauve scabious.

Inhabitants of the meadow.—The meadow is naturally the home of innumerable small creatures to whom the serrated grass blades must appear an interminable forest. Perhaps the children may see the leaping, chirping grasshopper, the cousin of the now somewhat scarce household cricket. Keats' beautiful sonnet on the grasshopper, "The poetry of earth is never dead," is, by-the-bye, one of the few poems in sonnet form that can be enjoyed by children of twelve, and will bring a meadow at noontide vividly before their eyes.

A less harmless insect is the grub of the daddy-

longlegs—the “leather jacket,” who feeds on the roots of grasses and would do more damage than he does were his kind not constantly devoured by rooks and starlings, who dig for him with their strong beaks. And equally mischievous is the larva of the cockchafer, which lives three years below the soil, colourless, blind, and a most voracious devourer of grass roots, except when he is hibernating in the winter, deep below the ground. At the end of the third summer he falls into the pupa stage, and in his fourth spring he emerges as a perfect insect, having burrowed six feet upwards with his strong head and legs. Then, as most boys know, he inflates his body with air, and flies away to a new life among the trees, where he begins depredations in a different sphere. As a larva, he mines so deeply that only that wrongly abused animal the mole can seek him out and destroy him, and thus save much wholesome herbage from impoverishment.

Banquets for Birds.—As the grasses ripen, the meadows are haunted by companies of greenfinches, linnets, and sparrows, even the town sparrow taking an outing in this way. These birds are vegetarians, and now they have opportunity for abundant feasts of seed. It is pretty to see a sparrow hovering in the air a foot or so above the tops of the grasses, looking for a foothold below where he may cling and eat. Later on the mown meadows are thronged by still larger numbers of birds gathering the fallen grass seeds, for those who have been rearing a second or third brood of young ones have finished their labours by this time, and are able to enjoy themselves. Insects abound also, and, having lost their covert of grass, are exposed to the sharp eyes of those birds who prefer insect food. “Every one finds something to his liking . . . little seeds, insects, and minute atom-like foods it needs a bird’s eye to know.”

CHAPTER XXVIII

IN SUMMER WOODS (I)

Indoor study of twigs.—The study of trees, we will suppose, has been begun in winter, when the characteristic framework of branches has been noticed in common trees, and when the colour, shape, and arrangement of the winter buds have been examined. Twigs of these trees have been placed in water in the school-room in order to let the children notice how the leaves escape from their buds and how they are rolled up inside their protecting scales. As the flowers appear, fresh twigs have been brought in, so that new elements might be added to the image of the tree as a whole. Fully developed sprays have been lightly stitched to white paper and displayed in the classroom, with the name of the tree clearly printed below. The teacher will find paper a very useful material for impressing points of structure upon children of eleven or twelve. With paper we may demonstrate how the leaves are folded within the bud; the shape of the leaf may be reproduced and the veinings marked on the model. And the teacher, with a cylinder of paper and a few tiny pins, may help the children to reproduce the various ways in which the leaves are arranged on the stem in different trees.

The tree as a whole.—Out of doors the purples and russets of early spring have given place first to bright tender green, and then to the full, deep, more uniform green of midsummer. We will suppose that these

changes, as well as the appearance of the flowers, have been duly noted on the "tree map" of the school or class. When the trees are in their full glory of foliage, the children should be taken to stand beneath some stately oak or beech so that they may gaze up into its branches, and *feel* rather than observe how noble and beautiful an object it is. It should never be forgotten that our chief aim at this stage is to create such a *feeling* for Nature as will colour all the more intellectual aspects of the work.

Its adjustments.—An acute observer has said, "Children care little for Nature if it has nothing to do with man." We should traverse this statement, but admit that children care little for Nature unless they can associate it with some such intelligible adjustments as they have been accustomed to find in man; in other words, unless the natural objects are shown to be *living* like themselves. Let them notice, therefore, how the trees adjust themselves to their environment. We have before suggested that they should notice how oaks and beeches spread abroad or grow up bare to a great height according as they are in the open or close together in a wood. Let them now notice that the shape of most of our forest trees, seen from a distance, is that of a dome, and seen from the base of the trunk is like that of an umbrella with huge ribs and a vast concave screen. It is a common experience to take shelter under a tree during a shower. Then they may notice that though the ground at the foot of the trunk is quite dry, there soon begins a profuse dripping from the tips of the outer branches so that a circle of moisture is formed all round the tree. When the shower is over, let them step back and once more notice how branches, twigs, and leaves are arranged, as Kerner points out, in *stories*, the lower projecting

beyond the upper, so that the rain descends from the higher to the next layer, and from these to the lower stories in succession, and so to the ground.

**Arrange-
ment of
branches to
dispose of
moisture.** Let them see how the details of a twig help this arrangement. The slope of the twig itself, the grooves along the midrib and stalk of the leaf (well seen in the ash), and the long-drawn-out tips of the lime and elm leaf, are all devices directed to the same end.

Now let them imagine the parts of the tree below the surface. In some trees, such as the beech or fir, they can see how far the roots travel from the trunk. Help

**Relation of
under-
ground
parts to
dripping
branches.** them to realise that beneath the soil there is, as it were, an inverted tree, consisting of a stout root striking downwards and innumerable root branches growing out from it on every side. Now the growing tips of these roots, which are the parts that extract the nourishment from the soil, correspond in position to the growing tips of the branches above, below which the ring of moisture is formed.

Let the children notice which of their garden plants—*e.g.* nasturtium; or hedge-plants, as mullein or thistle—behave in the same way. On the other hand, let them compare the different arrangements made by the bulb plants they reared in spring, and by such plants as rhubarb, lily of the valley, &c., where the rain is directed not outwards, but downwards and inwards along the funnel-like leaves to the root, which in these cases lies in a straight line below.

But the absorption of moisture is not the only consideration which determines the arrangements of branches, twigs, and leaves. Light and air, as we know, are of great importance. Hence the lower branches, which are in danger of being shaded by the upper, thrust out their growing tips as far as possible beyond

the circle of shadow. The buds along that part of the branch nearest the trunk are not developed. Each of

Adjustment of leaves so as to secure light and air. the great boughs or "stories" of the tree must provide as much light and air as possible for its inmates, and twigs and leaves must be fitted into one another like the rooms in a block of modern flats. This is the real meaning of the various

devices for the arrangement of leaves on twigs which we have noted in our schoolroom studies.

Their arrangement on the twigs. Sometimes the leaves are placed on the twig alternately, as in the beech; sometimes in opposite pairs at right angles so as to form a series of crosses, as in the ash and elder; sometimes in spirals, as in the oak. The usual

shape of a leaf is ovate, so that its tip, at least, does not screen its neighbours; and when there is any danger of overlapping, as in the oak, where, as we have seen, the

Their shape and divisions. spirals are rather close, the leaves are very much cut, so that light can filter through. Sometimes these notches are quite small, as in the beech and elm;

sometimes, on the other hand, the divisions are carried so far that one large leaf is cut up into many smaller leaflets, as in the ash and horse-chestnut (let the children determine that these are not whole leaves by discovering that there is no bud in the axils where they join the stalk, which is the midrib of the true leaf). In the lime and the elm, where the foliage is particularly dense, the leaves nevertheless, by a lopsided arrangement of the blade, let in light on their brothers. On an

Leaf mosaics. elm twig we may notice also that there are smaller and larger leaves, the smaller cunningly fitted into the spaces left by

the larger. Sometimes, again, as in the sycamore, the leaves are spread apart by differences in the length

of their leaf-stalks, thus imitating on the branch the mosaic we have seen on the ground in the case of colts-foot and ivy. Let the children look up into the tree and note the golden points and patches of light in the interspaces of the leaves. Point out to them how the light falls upon the tree, not vertically, but obliquely, from east, south, or west, according to the time of day, so that even the inner leaves get some share of sunlight during the twenty-four hours. Where the shade is quite dense, as on the lower inner boughs, leaves are not developed. The connection of physical well-being with abundant light and air can hardly be pointed out too often.

Relation of foliage to trunk.—Though one leaf by itself is insignificant, yet the character of a tree depends largely upon the number, size, and weight of its leaves taken altogether. If the leaves are large and numerous, there is a corresponding weight to bear, so that trees which carry broad sheets of foliage, such as the oak and the beech, must have thick, massive trunks. On the other hand, the birch has fewer, smaller leaves and therefore its trunk is slighter.

The "habit" of a tree.—Trees may be known by the way in which the leaves hang from their twigs. The foliage of the lime lies in horizontal sheets, but the leaves of the birch, the ash, the various kinds of willows, the poplars, and especially the ever-trembling aspen poplars, are furnished with longer stalks so that they hang more loosely and vibrate more readily in the wind. These give less shelter to the birds than the closer-leaved trees. On the other hand, these are the *graceful* trees, which have their own charm in contrast with their sturdier brethren. If the oak is the "king of the forest," the birch is the "lady of the woods," so familiar in MacWhirter's picture. If our pupils are to grow up lovers of trees, we must do all we can to render them individually recognisable, each in its own habit as it lives.

CHAPTER XXIX

° IN SUMMER WOODS (2)

Terms describing woodland scenery.—The woods we find in England are sometimes survivals of the great tracts of native forest which once spread over the whole country. The Forest of Dean, Charnwood Forest, and Epping Forest are such remnants. Many woods, however, are *plantations*—i.e. trees which have been set in the soil by man and are not the result of seedlings springing as Nature chooses. Moreover, since all woods in modern time are the property of some person or public body, they are all kept in order, the trees are prevented from overcrowding, undergrowth is kept down, and paths are made. Tell the children stories of Gurth the Swineherd, of Robin Hood, of Una and the Red Cross Knight, to help them to imagine what the wild wood was like when it was less trimmed by the hand of man, and describe (using pictures) the dense growth, the gigantic creepers, the darkness of a tropical forest, that they may realise what Nature can do when she is left alone. In Britain, by-the-by, the word "forest" is applied not only to a tract of woodland, but also to any wild district not under cultivation, even if large trees are absent, as in the "deer forests" of Scotland, and Ashdown Forest in Sussex, which is a tract of sandy heath.

Let the children note the meaning of the word *copse* or *coppice*, a wood in which the trees are only allowed to

grow to a certain height and then are "copped" or cut, for some economic purpose; thus in the hop districts young ashes are cut to make hop-poles, and in some parts of Sussex there are copses of Spanish chestnuts which, after seven years, are cut down for making into barrels, &c. A *spinney* is a tiny bit of woodland in an open field or on a hillside to give covert for game.

The minor plants on the great trees.—In a ramble through a wood, the children will find that the trees themselves are but giants in a great company of plants of many kinds. If the trees are giants, the mosses and lichens which we find on their trunks are among the smallest of vegetable creatures. The lichens will be found on the dry parts of the trunk, and the mosses on the damp parts, and also on the great limbs of the roots that protrude above the soil. The lichens are little pale, crusted, or cup-like plants which have no distinct * root, stem, leaves, or flowers. Mosses, on the other hand, have leaves and stems, though these are very simple; and whereas the lichens hardly ever thrive except in dry situations, the larger mosses, at least, prefer moisture. The teacher should read Ruskin's praise of lichens and mosses in "Modern Painters," and he will ever thereafter see in these delicate "fine filmed, humblest, most honoured of the earth children," beauty and grace that will help him to quicken the eyes of his pupils, and to appreciate more and more that exquisite economy of Nature which clothes gaunt and bare places with "unimaginable fineness of gentle growth." Later on in the year, the trunk of the tree may show, in parts where it has begun to decay, great brackets of quickly growing fungi.

The undergrowth.—In the open spaces between the great trees are springing saplings, smaller trees such

* The teacher should know that a lichen is really a partnership of two plants—a green alga tangled among the threads of a fungus.

as hawthorns and hollies; and straggling bushes, such as bramble and wild rose. Other climbing plants, such as ivy, will cling to the trees themselves. (It is this undergrowth, especially of climbing plants, which makes a tropical forest so difficult to penetrate.) Often in our English woods laurels and rhododendrons are planted in the open spaces between the trees to make brighter patches of colour.

The floor of the forest.—The floor of the forest is rich in all kinds of treasures. Let the children search round the bases of the trees for their seedlings. Only a few of these will survive, but they get a good start in the hotbed of dead leaves which each tree sheds in the autumn, and which form a rich vegetable soil, or *humus* as it is called. Besides the wood grasses, the mosses and ferns, and nettles, we shall find in succession the little green-flowered dog's-mercury, the wild hyacinths, growing in sheets which look like patches of blue sky dropped between the trees, the delicate wood anemone, the still more delicate wood-sorrel, which goes to sleep in the afternoon by folding up its three leaflets with their under-sides touching one another, and hanging them downwards from the flower-stalk (compare with the sleeping habit of clover leaves). Later on in the year, wild raspberries, campions, and foxgloves are found in abundance. Whenever a clearing is made in a wood, these "weeds" soon take possession, and are followed by hawthorns and brambles.

Let the children notice how the carpet flora varies. In fir woods we find nothing growing but the bracken fern, and the shade of a beech is so dense that scarcely anything will grow under it except perhaps dog's mercury, wood sanicle, and its own seedlings, which thrust up their curious seed-leaves like two green, fleshy hand-screens.

Animals of the wood.—The wood is not merely a plant world. In each region—in the foliage, in the tree-trunks, in the undergrowth, and on the floor and beneath the floor—there is, of course, animal life in abundance. Each tree gives shelter to myriads of insects. If we take the common oak, for example, we find it haunted by the cockchafer, who, as we saw, lives the first part of his life as an underground root-eating grub. Now he devours leaves. The great stag-beetle, whose “horns” look so formidable, feeds on those parts of the tree which have begun to decay. Some insects haunt the leaves. Certain of these (the leaf-rollers) twist the edges of the leaves over themselves so as to make a secure retreat. Others saw into the tissues of the leaves. The various kinds of galls on the trees, of which the oak-apple is one, were caused by insects laying their eggs on the leaf or end of a twig, and introducing at the same time some substance which actually altered the tissue of the plant and changed it into a convenient shelter and larder for the young which were to be hatched.

The insect life of the trees.

Bird life in the woods.—Some of this insect life is kept in check by birds. The woodpecker, for example, props himself up against the trunk of a tree by a stiff tail which is like the back portion of an easel, and with his toes—which are arranged in two pairs of two each like the parrot's, and not three in front and one at the back, as is the case with most English birds—he holds on to the bark, which he taps with his strong beak in places where he suspects that insects abound. Then he thrusts out a long, sticky tongue, to which small insects adhere, while larger ones are caught in its sharp, forked point. Another curious bird, the nuthatch, may perhaps be seen *running* up a tree just as a mouse does. It will climb in this way on the *under*

side of branches. It is called a nuthatch because it uses its strong beak to hatch or break the shell of the nuts on which it lives (cf. hatchet).

The songsters are nearly all silent at midsummer; but the harsh call of the cock-pheasant and the whirr of his wings may perhaps be heard on the borders of the wood, and the children may hear the scream of the jay and catch the flash of his beautiful blue plumage. They will most likely hear the monotonous coo of the turtle-dove, or the large, heavily-flying woodpigeon calling: "You are so pretty! You are so pretty! You!"

Beasts of the woodland.—The squirrel may be seen running with a flick of his tail up the side of a tree, or leaping from bough to bough. Down below, in the brambles, the dormouse has a little nest, and the hedgehog may be coiled up among the fallen leaves at the foot of the tree. Rabbits who penetrate into the wood from their warrens find plenty of green sappy shoots on which to browse in the evening or early morning. Perhaps a fox has his lair in a thicket. Not all Londoners know of the herds of deer which feed in the open glades of Epping Forest near High Beech. With all these varied inhabitants a great wood is not only a delightful desert, but, as Shakespeare said, a "desert city."

"The spirit in the woods."—Manage a picnic to a wood with discretion. Let the rough games be played in the open glades, but, as Wordsworth says:

Move along these shades
In gentleness of heart; with gentle hand
Touch—for there is a spirit in the woods.

Under the shade of the great trees it is best to sit quietly telling stories of woodland life—perhaps such stories of

woodland life in other lands as we find in Rudyard Kipling's "Jungle Book."

And it is good to have pauses in which the children can gaze quietly up into the huge domes of tree, and feel in their young souls something of that romance, mystery, and religious awe which led our ancestors first to worship in their shadow, and then to reproduce in the soaring pillars and fretted vaults of our great churches the light and shadow, the vastness and silence, the solemn, soothing peace of a forest temple.

CHAPTER XXX

TREES IN TOWNS (I)

Trees in a town park.—While it must be confessed that an urban park is less attractive than a bit of real woodland, yet the town teacher will find that it offers many advantages for teaching purposes.

Whereas in a wood the trees are often planted together, oak by oak, beech by beech, in a park or open space there is often great variety, each kind of tree being planted in the situation that will display it to the best advantage. Thus in Battersea Park, in Kew Gardens, or on Hampstead Heath, the young Londoner can, within a quite small area, make acquaintance with almost every kind of tree that will grow in this country.

Though we have not in England at present the institution known in America as Arbor Day, yet authorities are showing praiseworthy regard for the beautifying of our towns by planting trees in parks and along the thoroughfares, and the children should be taught not only to refrain from damaging these, but to take a pride in them. It should also be pointed out

Effect on bird life. to them that the encouragement of trees and undergrowth in the parks has resulted in an increase in the bird population of towns. Quite a long list of birds seen in Regent's Park was drawn up for the "Country in Town" Exhibition, held at Whitechapel in 1907. In Battersea Park kingfishers have brought up their young, and a cuckoo has laid its egg in a sedge-warbler's nest.

The plane.—The plane is the tree which is most often planted by the side of thoroughfares. It can easily be recognised in winter by the curious, sculptured, globe-like fruits which dangle from its bare boughs, and by the greenish-grey patches on its trunk, showing where the old bark has naturally shredded away. It is this property of getting rid of the soiled bark which, it is thought, enables the plane to endure

Its bark. the smoky air of our towns so well. The children will be amused to hear of the sapient Borough Council which offered a reward for the conviction of the imaginary offenders who had been peeling the bark from the plane-trees on the boulevards under their care.

In the winter the twigs show alternate buds, thick, curved, and pointed, and of a dark-red colour. The leaves appear late in the spring, and they have swollen bases which hide the young buds of next year. It is the broad nobly-shaped leaf which has given its name

Its leaf. to the tree. Late as they are, these leaves come quite in time to make delightful domes of green shade at frequent intervals along the white pavements that reflect so pitilessly the glare of the summer sun. They are not rough in texture, like those of the hazel, for instance, but so smooth and polished that the slightest shower speedily washes them free from dust and soot. They are set so far apart from one another as to be able to obtain plenty of the light and air so specially necessary in towns. It has been objected that this loose arrangement of the leaves makes the plane-tree of little use for giving shelter to the birds, and the objection must be admitted. On the other hand, the arrangement results in beautiful effects, almost peculiar to the plane. Let the children notice what bold and clear-cut shadows, with all the graceful lobes showing distinctly in their curves and

points, these separated leaves throw upon the pavements, especially when the shadows are deepened by contrast with the strong glow of the electric light; and what a beautiful fairy dome of golden green is lighted by a street-lamp placed close under the tree, so that the glow is thrown up on to the under sides of



FIG. 39.—LEAF AND FRUIT OF PLANE

the leaves. It needs to be a dweller in a town to see effects like these.

In May and June, when the leaves are still young, the children should look out for the new flowers of the plane. They will see long stalks (2-6 inches) with what look like two or three large globular buttons threaded on them, with spaces left between. The smaller buttons are the

pollen-bearing flowers or stamens, which are borne on a stalk by themselves. When the pollen is shed, these catkins fall to the ground. The larger globes on the other stalks, which are to form the fruits, will, however, remain hanging, as we have seen, throughout the winter. Each globe consists of a number of little nuts with tufts of bristles growing from it, these giving it a sculptured appearance as seen from below. But the plane-tree does not sow itself; it is not a native of this country (having been first introduced by the father of the great Lord Bacon), and it only grows where it is planted, so that we do not find it in woods or in the open country, where earlier-leaving trees are generally preferred.

The plane, hardy as it is, has its own enemies. Of these the most formidable is the caterpillar of the vapourer moth, which, like his victim, takes quite kindly to a town life, haunting trees and squares, where he may be seen flitting about in August.

London
planes and
the
vapourer
moth.

The vapourer moth is a small, reddish-brown moth, with dark markings, and two white crescents on his front wings. It needs sharp eyes to discover his mate, who is to be found only on the tree itself, for she is wingless, and never leaves the spot on which she is born. Other Lepidoptera, as we have seen, develop wings during the pupa stage, wherewith, on becoming perfect insects, they can fly away and find a fresh feeding-ground for the next unborn generation. But trees, unlike herbs, provide abundant food for many families, and so it has come about that the female vapourer moth, on emerging from the cocoon within which she passed her pupa stage, simply remains there; there she lays her eggs, and there she dies.

In the summer of 1906, the curious hairy caterpillars of the vapourer moth were so abundant in Hyde Park

that the receipts for hire of chairs in this favourite resort of Londoners fell so considerably as to cause the authorities great concern. It became a matter of courtesy for strangers to brush the caterpillars away from their neighbours, or to give warning of their presence. At the end of the season all the trees were syringed with an insecticide fluid in order to prevent a recurrence of the pest in the next summer. Thus, even in towns, man steps in and arbitrates, as it were, between opposing forces in Nature. The vapourer moth is very interesting to naturalists; but the tired Londoner must rest in peace beneath the shadow of his plane-tree.

The sycamore.—But the plane is not the only tree that will thrive in towns. The sycamore, whose leaf is somewhat like that of the plane, is often found in our squares, parks, and suburban gardens, though, having been longer known in the country, it is also found much more frequently in rural districts.

So like is the sycamore to the plane, that we can understand how it comes to be called *Acer platanoides*, or, as the elder children may be told, the plane-like maple. For it is really a maple. The true sycamore, of which we read in the Bible, in the story of Zacchæus, is the fig mulberry. In the miracle plays of the twelfth and thirteenth centuries the maple or mock-plane, as it was then called, was substituted for the true sycamore, which does not grow in England. Hence the maple acquired the name by which we now know it, and hence, too, it became a very favourite tree.

Having pointed out the likeness between the leaves of the plane and the sycamore, we must now exercise a faculty which well-taught children delight in using—the faculty of discrimination. This will bring out the following differences arrived at, let us say, as the result

of a little "problem" proposed by the teacher for the next Nature lesson: (1) The sycamore leaves are in opposite pairs, while those of the plane are alternate, on stalks of irregular length; (2) the foliage of the sycamore is much denser, so that it casts a deep shade; (3) the lobes of the leaf itself are less pointed; (4) the leaf is of a darker green, and not so polished.



FIG. 40.—SYCAMORE LEAF

There are also marked differences in the *flowers* and *fruit* of the two trees. Instead of hanging globes, the sycamore has long hanging bunches of scented green flowers. When the fruit is ripe, we find it hanging in "keys." Each seed has two spread-out wings, curving somewhat towards each other, so as to form a broad letter U, and tinged with red (*vide* p. 340). Note that the ash "key" has only *one* seed, and whereas the ash keys linger on till deep into the winter the double scimitar of the sycamore fruit is spun away by the autumn winds much earlier. The

red of the fruits is characteristic of the sycamore, whose early leaves and stalks are also tinged with red, and whose fading foliage shows the same colour. Bees love the sycamore almost as much as they love the lime, and the aphides are so fond of it that their "honey-dew" constantly falls from it in summer.

Comparisons with hedge-maple.—The *hedge-maple* is a much smaller tree than the sycamore or plane-like maple. It is often found in hedges, side by side with the hawthorn, whose leaves are somewhat like its own.

The fruit of the hedge-maple is double-winged, like that of its larger sister; but instead of bending down to form the letter U, the wings are stretched out straight on either side of the seed (*vide* p. 340). The collecting instinct may be harmlessly employed in connection with fruits and seeds, and even a town child will have opportunities of acquiring specimens of these fruits, which, by the way, form excellent studies for drawing and elementary design.

CHAPTER XXXI

TREES IN TOWN (2)

The lime.—The lime is one of the commonest as well as one of the most beautiful trees that will thrive in the open spaces and suburbs of towns. Its true name is the Lind, Linden, or Line-tree, so called because of the ribbon-like strips of the inner bark. The stem grows straight, with smooth outer bark. At some distance from the ground there is often a thick growth of branches which makes an excellent covert for birds, and the higher branches form a beautiful dome. We may know the lime in spring by the lovely coral-pink

Its buds. of its buds. On looking closely at a bud we find that the bright colour is due to little scales or stipules at the base of the leaf-stalk. Within the pink outer scales are other scales, and these are packed between the tender unfolded leaves like folds of tissue paper placed between the layers of a delicate fabric.

When the bud opens we find each leaf still protected for a time by its coral-tipped stipules, and hanging down from its twig in a very helpless fashion, as we have seen the horse-chestnut leaves hang. The elder leaves are folded over the younger and more delicate ones as though to shelter them. As the tissues become firmer, however, the scales drop off, the leaves become nearly horizontal,

standing out alternately on either side of the twig, but each drooping just a little towards the tip, which is drawn out into a point, on which the raindrops gather, and from which they fall to the leaves below and beyond them. Each "story" of the lime-tree shows beautiful sheets of foliage curving down just a little at the growing-point.



FIG. 41. — LEAVES AND BLOSSOM OF THE LIME

The drawn-out tip of the leaf repeats on a small scale the inclination of the whole foliage mass. When the children draw the leaf they will notice that the two halves are not alike, one side having a hollower curve than its fellow. This arrangement is useful in letting light and air through the interspaces of the great sheet of foliage.

Lime-trees are often planted in avenues, and the flat sprays of the branches make a green roof which is very pleasant in the heat of summer. Though the leaves have

lost their first tenderness of colour, yet a lime-tree is very beautiful in June and onwards through the summer.

Its blossoms. For in June appear the curious dainty blossoms, which no one forgets after once seeing them. A bunch of small yellowish-green flowers hangs from a pale, honey-coloured, ribbon-like "bract," or undeveloped leaf. The stalk which bears both bract and flower is long and pendent, so that the pale blossoms dangle from among the leaves. Here they attract hordes of bees, for the little blossoms are rich in honey, and advertise it by a delicious fragrance. Lime-blossom honey is especially choice, though it is very difficult to obtain it unmixed with the honey of other blossoms.

It will be seen that the lime resembles the sycamore in the attraction that it provides for bees; and, like the sycamore, it is haunted by swarms of aphides, whose "honey-dew" drops freely from the leaves; hence we do not find either the lime or the sycamore planted upon lawns.

As the lime was one of the earliest trees to show its leaves, so it is one of the first to shed them, and the yellow drifts come down quite early in the autumn. Then its fruits—little nut-like bodies about the size of a pea—will be floated away on the wind, each cluster being borne through the air by its bract, which serves as a wing or parachute.

In June let the children look on the leaves of the lime-trees for the caterpillars of the buff-tip moth, yellow, hairy creatures with seven broken lines running down their bodies. They will be found sociably huddled together in companies, eating the leaves with a persistence which sometimes leads to the disfigurement of the tree. Round about the roots of the lime the children will find the

Moths on lime-trees.

black-ridged pupa-cases which contain the caterpillars of last year, and they may watch the emergence of the beautiful pink and mauve moth with the large buff blotches at the tip of the front wings which give it its name. The lime-hawk and the vapourer moth also haunt the lime-trees. On some leaves, too, the children will find curious little nail-like structures standing up from the surface. These "nails" are due to the action of gall insects, who, laying their eggs within the tissues of the leaf, cause the conversion of the region near into a suitable cradle and
"Nail" galls. larder for the maggot when hatched. The special insect which chooses the lime produces changes which give it the appearance of being studded over with these green points.

The elder.—Another tree that is very kindly in its benefits to towns is the elder. An elder growing in a back-yard in an angle between a wall and a dust-bin, and within a foot or two of flags or asphalt, is a very different object from an elder growing out in the open country, but it is a real delight to thousands of humble folk who like to see anything resembling a tree near their homes. The trunk of the elder is brownish-grey, and if neglected it sends up from both roots
Its stem. and branches vertical shoots like rows of canes. The young shoots contain a pith which is so soft that boys can easily push it out to make pea-shooters and pop-guns. These vertical shoots not uncommonly die after their first season, and when dead they are very brittle.

The tree does not grow very high, but it makes amends by its multitude of leaves. These grow in pairs opposite to one another on each side
Its leaves. of the stalk, and each leaf is divided into five or seven notched leaflets, so that it is a compound leaf, like that of the ash.

The flowers are very tiny, but very beautiful, with five waxen bosses (the petals) alternating with five points (the stamens), reminding one of the "egg and dart" pattern so often seen in architectural ornament. Though individually small, the flowers make a brave show by the device of crowding themselves together. Five main stalks all start from the same point of the stem, but the outer ones grow longer than the inner, and they all branch in such a way as to enable all the flowers to lie in one plane, forming a broad white plate, or platform, sometimes nearly a foot across. The white gleaming platform is intended to attract insects, and this end is further secured by the heavy odour which comes from the fully-developed flowers, as well as from the leaves. We have before noticed that nearly all white flowers are more strongly scented in the evening, and it is in the evening that the suburban householder draws his chair farther away from the elder-tree in full flower. When the flowering is over and the juicy purple berries hang down from the stalks which were once lifted up to form the floral platform, thrifty people make elder-berry wine from the fruit. The children may know that the flowers themselves are useful in making lotions and perfumes, and they may be told how the great physician and botanist, Boerhaave, used to take off his hat to every elder-tree as he passed it, in recognition of its medicinal uses. Tell them that our ancestors believed it to have the power of keeping away evil spirits, and this is why it was often planted by cottage doors. Information of this kind is not Nature study, but it assists Nature study by placing natural objects in a centre of human interest, thus adding the touch of feeling which vitalises observation of inanimate things.

The Lombardy poplar.—Children ought to love the

Lombardy poplar. Planted in long rows by the side of interminable highways, as we see it in some European countries, it is somewhat monotonous, but in small groups, rising above other trees, in a row along a garden, or by a stretch of water, it is very beautiful. It is the most aspiring tree we have; the ascending habit of the branches produces a beautiful, pointed, flame-like column, which must surely seem to the town child "close against the sky." These "slender tops" are, moreover, so sensitive to the least touch of wind as to carry out the comparison with a wind-blown flame. There is a life, a vivacity about every part of the tree. The roots will give off suckers, quite contradicting what children are so often taught in botany lessons—that roots do not give off leaves or leafy shoots. Each leaf quivers at the least motion of the wind, as is the case more or less with all the poplars. This is because the leaf-stalks, especially those of the lower leaves of a branch, are very long, and also because the stalks are slightly compressed or pinched from side to side. Hence the leaves hang very loosely, and easily swing round edgewise to the wind. There is thus a constant twinkling in the branches from the play of light on the polished triangles of the leaf-blades. This also accounts for the rustling of the leaves, which makes the poplar one of the most musical of trees.

It is worth while distinguishing for the elder children the *white* poplar, whose leaves are white and cottony on the under surface, and the *black* poplar, whose leaves have not this characteristic.

The aspen is a variety of the white poplar, but the under side of its leaves is silky or smooth instead of downy. The leaves of the aspen poplar especially show the quivering motion characteristic of all the poplars. The elder children will associate with it the mediæval legend that

the wood of the Sacred Cross was obtained from the aspen, and that the tree for ever shudders at the wrong in which it played a helpless part. These fragments of folklore which have been carried down in the human memory for so many generations may be most fitly associated with the intelligent observation of Nature in the imaginative period of childhood.

CHAPTER XXXII

HOLIDAYS BY THE SEA.—(I) PLANT LIFE

Nature study and holidays.—Among the many benefits which we may expect from a deepening interest in Nature study in our schools is an improvement in the character of the children's summer holidays. We may hope that very soon the one-day "treat," noisy, crowded, excited, will be replaced by frequent quiet rambles in which a few children with their class teacher will learn to know one another better as they look at beautiful things together in the open air. And for those children who are fortunate enough to enjoy a summer holiday away from home we may hope better things than are afforded at present from the mere change from one town to another big crowded town that happens to have the sea on one side of its principal thoroughfare.

In the meantime the teacher can do something to provide the children who go to the seaside with other interests than those afforded by the "minstrel troupe" and similar "entertainments" on the sands. He will realise, of course, that a holiday on the shore appeals to those primitive instincts of dabbling in water and of constructive play which are innate in every child, and which have so little outcome in city life, and he will expect and encourage the building of sand castles and the digging of moats and trenches. But he will also realise that another instinct, the nomadic,

exploring instinct, may now be exercised in a new field, that magical, mysterious region "where land and sea mingle, and he will take advantage of this instinct to kindle a curiosity which may become a permanent intellectual interest.

Preparation and review in school.—It is quite legitimate in this case to give some kind of information beforehand. The teacher may describe his own experience; he may invite reminiscences from children who may remember their past seaside holidays; he may show them pictures and drawings of the things they are likely to see. The promoters of the Children's Country Holiday Fund, knowing that they whose alpha is ignorance have ignorance for their omega also, give lantern talks to the pupils before they leave town; and the ordinary teacher will do the children a service if he makes some such preparation with his own class. "Problems" set before the holidays can be discussed in conversation lessons when school opens again; paper models, sketches, shells, and specimens of dried seaweed can be shown; and if the teacher spends his own holiday at the seaside he can use the opportunity of providing on his return a marine aquarium which shall be a delight and a reminder for his pupils during many months afterwards.

Observations on the areas of a strip of coast.—Ask the children to be ready to tell, when they return, whether the shore they visited was low and sandy, as in the Lancashire health resorts or on the east coast, or whether there were cliffs, as at Margate. If there were cliffs, were they steep or not? Of what colour were they? At Margate the children will find white chalk, in Cornwall purple slate rocks with deep narrow inlets, on the South Devon coast the red sandstone. The teacher will make a point of knowing something of the "build" of the nearest coastline to which his

pupils will probably resort. Even on a low sandy shore there will probably be a tiny cliff or line of sand-dunes. At such places as Hastings, Folkestone, or Scarborough the bold cliffs will be a chief feature. Help the children to distinguish the various areas or zones of the shore. (1) The cliffs. (2) The boulders of stone at the foot of the cliff, which originally formed part of it, but which have become detached by the action of frost or the shock of beating waves in storms. The stones near the foot of the cliff are rough and angular. Those further out are more rounded. Why is this? (3) The shingle, or coarse pebble area. (4) The flat or shelving sand-belt. (5) The mud or ooze at the extreme verge, uncovered at low tide. Do they find that the same kind and colour of stone is to be seen as they travel from the cliff to the edge of the sea? Are there any pebbles like the rock of the cliff? How came the pebbles to be so beautifully round and smooth? What markings have they noticed on the sands at low water? (rippings made by waves, marks of the feet of sea-birds, &c., worm-casts, and borings of worms and molluscs).

By some such questions as these the children will be prepared to realise that the sea is not merely a huge tract of water reaching out to the horizon, but the agent of mighty forces grinding down the rocks into pebbles, and these into sand and ooze, wearing away the shore in one place and heaping up banks in another. Geology and physiography are, not studies for young children, but our pupils may make their own simple observations on the phenomena involved, and thus divine how men are able to spell out the past history of the earth.

Altered conditions of animal and vegetable life.—At this verge of the land, too, they meet with a flora and fauna quite different from those which flourish under

purely terrestrial conditions. They are in the presence of "the great and wide sea also; wherein are things creeping innumerable, both small and great beasts." The mystery of life in the deep seas can only be faintly imagined, but some of the transitional forms occurring on the coast will come under the direct observation of the children. We cannot expect them to follow out the peculiar adjustments to a watery environment, which explain some of the curious forms they will meet. It is enough, perhaps, at this stage if they realise the quaintness and wonder of these forms of life.

The flora of the shore-belts.—The animals are doubtless the more interesting, but the flora of the seaside need not be overlooked. This flora varies in the different belts that we have traced from the cliff edge to the sea margin. On sandy shores the children will not fail to notice the coarse grass growing upon the low sand-hills near the sea. They will find that the

The dunes and cliffs. blades of this grass are very harsh, almost knife-like, and that it is nearly impossible to drag up the plants. This is because the grass has strong burrowing root-stocks which run along under the soil, sending downwards very long roots, and pushing upwards their tufts of coarse blades. These grasses so bind together the loose sand as to prevent it blowing inland over the cultivated fields, and the dunes are also useful as barriers against the wind. How strong and salt the wind can be at the seaside the children can tell by noticing the growth of trees near the coast, how the whole tree seems to bend landwards, the branches on the side nearest the sea being very stunted.

Upon the dunes and on sandy cliffs we often find such plants as the prickly sea-holly, the sea-rocket, the saltwort. Farther back little herbaceous plants, vetches

and the like, will grow on the turfy matting formed by the decayed roots of the original "bents." Golf-links near the sea are very popular, not only because of the good air, but also because of the specially short, springy turf which we often find there—a delicate elastic mattress, as it were, forming a thin covering to the firm "poor" soil below.

Let the children notice what vegetation they find at the high-water mark, at the low-water mark, and between these limits. At the high-water mark they will find the flotsam and jetsam of the shore—a belt of wreckage which has been left behind by the waves.

Among *débris* of shells, bits of wood, skeletons and corpses of sea-creatures they will find fragments of seaweed torn away from their moorings. Below the high-water mark they

will find trails of slimy green algæ—simple plants without distinction of stem, leaves, or root. Nearly all sea "weeds," by-the-bye, are algæ, and though some of these appear to be branched, there is no putting forth of leaves or flowers such as we find in higher plants.

Below this belt, near the low-water mark, we find the large coarse brown fucus, or bladder-wrack, with a tough, leathery stalk and branching fronds. The

little spores which reproduce the plant are found in bladders at the end of the fronds. On the fronds themselves are air-bladders which float the plant in the water, and which

the children will like to "pop." The ground colour of the fucus is olive-green, as may be seen by pouring hot water over a bit of it, when the surface brown dissolves away. The red algæ grow at the extreme edge of the shore, where they are only exposed at very low tides, though, as they are very delicate, we often find fragments of them on the upper part of the beach, especially after a storm.

These also have green tissues underneath the red, for water plants no less than land plants need to build up their tissues by the "living green" which we find in these tissues. But those plants which are exposed

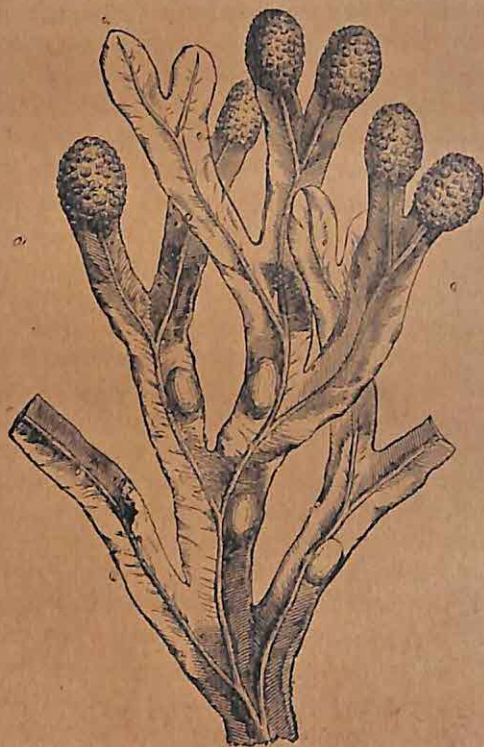


FIG. 42.—BLADDER-WRACK.

alternately to the action of light passing through water at high tide, and of direct sunlight at low tide, need to have their 'green tissues protected, and the brown and the red are the colours best adapted to the respective depths at which they are found.

The low-
water
mark.

Far out, too, in the pools of the farthest rocks exposed at low tides, we find long, slippery, strap-like weeds or "tangles" (*Laminaria*). These adhere to the rocks at the side of the pool by discs which are *not* roots, but which serve as anchors, holding them while they sway to and fro in the water, so as to have their tissues in it and thus take up the air they need. They are torn up when the tempests are very high, and then we sometimes find fragments of their long ribbons on the upper shore. Clinging to the sides of the rocks, often hidden by coarser weeds, are delicate red and green algæ of various kinds. It is to this kind of pool or cleft

**Weeds
for the
aquarium.**

that the teacher who is making a marine aquarium must come to seek the weeds that are essential to liberate oxygen from the water in which the animal inhabitants are to live. The coarser kinds will soon decay, and spoil the water. He must chip away a little of the rock to which these more delicate seaweeds cling, and carry them away as they grow. The emerald green ulva, or sea-lettuce, which holds out its thin crinkled tissues like a fan, is especially useful. The weeds are often the haunt of sponges and worms, which must be removed. Then the weeds, each anchored to its scrap of native rock, can be put into a bell-jar, the bottom of which has been filled with two inches of clean sand from the seashore. Salt water must be added, and the weeds left a day or two before the animals are put in. It is possible to keep such an aquarium for many months, merely supplying fresh water occasionally to take the place of that lost by evaporation.

If it is desired to have a larger aquarium, directions will be found in the "Handbook to the Marine Aquarium" (*Id.*), issued by the London County Council, and obtainable at the Horniman Museum, Forest Hill.

CHAPTER XXXIII.

HOLIDAYS BY THE SEA.—(2) SHELLS AND "SHELL-
FISH": UNIVALVES

Animal life on the shore.—As we have said, it is the *animal* life of the shore that will mainly attract children, and the primitive interest in watching *movement* will be exercised in all kinds of new ways on the edge of the waters themselves, the ever-moving cradle of all the myriad forms of life. Though we think and speak of the "fishes of the sea," yet as a matter of fact

Fish. the children will come across very few live fish while at the shore. Now and then they may see little fish in the rock pools, but their best opportunity of learning the different kinds will be afforded when the fishing boats come in. Then a good-natured fisherman will perhaps tell them the names of some of the silvery creatures his boat has brought to land. Probably the best way to make a child realise the *life* of a fish is to take him to a good aquarium. Such collections as that attached to the Marine Laboratory at Plymouth will be specially interesting to the teacher. The contents of the tanks are revelations of the grace and colour, as well as of the eccentricities of form, that are to be found in the great world of waters of which we know so little.

It is the study of creatures lowlier in the scale of creation than the fish, viz. the crustaceans, molluscs,

echinodermata, &c., for which the margin of the sea gives such good opportunity. It is worth while warning

the child that the words "shell-fish," "jelly-fish," "star-fish," and so on, are not true descriptions of the kind of creature to which they are applied. Let the class consider

once more the backbone and fins of the herring, which observation will give them a starting-point of comparison with the backboneless creatures which are loosely called "fish."

Molluscs.—To begin with the molluscs. Before the children leave for the seaside, the teacher will be wise to let them look carefully at the common garden snail, and they will notice that it has a soft body with no limbs. The character of the body may be noted in the slug, where the shell is absent or reduced to a small, hard, slightly concave plate under the skin. The snail's body is protected by *one* shell (univalve), which is really a coiled tube. In walking, a part of the body is thrust out in front and rear of the shell, which rises like a dome over the middle. If snails of different sizes are compared, the children will understand, by noticing the lines of growth, how the

The snail
as a type
of the
univalve.

animal gradually adds to the lip of the shell. The snail has a distinct head, with two pairs of feelers; the longer and upper pair of these carries the eyes. Teachers are generally very conscientious in explaining, with the help of a hat-pin stuck through the finger of a glove, and pulled back from within, how the eyes can be withdrawn into the feeler as into a sheath. But we must confess to having heard very many lessons in which the teacher forgot to suggest to the children that they should notice the beauty of the spiral, of its markings and colourings, and make drawings of what they had observed in their individual specimens.

The garden snail is a vegetable feeder, rasping at leaves with a tongue that is beset with small hard "teeth." Its lipped mouth can be seen through glass or by looking upward through the hole it has made in the cabbage it is devouring.

Now compare this with an oyster, a typical bivalve easily procurable in towns. Here the shell is in *two* pieces, hinged together at one corner. On either side of the soft body are the folds of a delicate membrane, the mantle, which have been compared to the fly-leaves of a book, the shells forming the cover. It is this

The oyster: mantle which secretes the material to form the shells. **a bivalve:** The edges of a similar mantle

may be seen as a kind of collar or frill round the shell of a snail. Within the oyster-mantles are a pair of gills, one pair on either side of the body, which lies in the midst, like the leaves of a book. Let the children notice the strong muscle which holds the shell-valves together in the living creature.

The oyster, it will be noted, is a lowlier type of mollusc than the snail, in that it has no distinct head.

"Shell-fish": nivalves. — With these two types well established in their minds, the children will be interested in searching on the beach for other shells of each kind — the habitations of the so-called "shell-fish."

On the sand-hills near the sea they will find varieties of *land-snails*, air-breathers, which have semi-transparent, brittle shells. Farther out on the shore and **Sea-snails.** in the rock pools, sea-snails will be found, which breathe air that is dissolved in water. These often show very beautiful colours, green and pink dappled with brown being the most common. These are very useful in aquaria, for they nibble away the growth of green algæ that often appears on the glass sides of the jar or tank. The mollusc that will remind the children

most closely of the land-snail is, of course, the periwinkle. They will easily recognise the edible kind ; indeed, it is possible that a teacher in the very heart of a town might find this a more convenient preliminary introduction to the univalve form than the common snail. The little blunt, orange periwinkle-shells, which are so often found empty on the shore, are great favourites with children.

More unlike the snail in appearance, but nevertheless to be classed with the sea-snails, are the whelks and the limpets, both very familiar objects at the seaside. It is worth while pointing out that those which have a notch to their shells, like the whelk, are animal feeders, while those whose shells are unnotched, like the limpet, eat vegetable food.

The children will be sure to see companies of limpets clinging to the rocks between tide-marks, their curious pointed shells looking like the tents of a miniature army. The soft "foot" within holds like a sucker to the rock, and even wears away a cup-like cavity on its surface. We often find little creatures (corallines) or green and purple weeds fastened to their shells as to the solid rock. Notwithstanding its motionless appearance the limpet *can* move, gliding very slowly over the rock, perhaps for a foot or two, though it likes to return to the special little hollow it has made for itself.

The whelk will be familiar to town children, who will have seen it on fishmongers' slabs and barrows.

Whelks. Now they may perhaps find empty shells washed up on the beach. The creature who once lived in an empty whelk-shell (let the children notice the notch) was a very voracious creature. Shells are often picked up which show round holes neatly bored in their sides ; this is the work of whelks or of other carnivorous sea-snails. With their rasp-like

tongues, studded with flinty teeth, they bore the shells and suck out the contents. Like the periwinkles, whelks can close the opening of their shells with a kind of lid (operculum).

It is very common to find on the shore clusters of yellowish, leathery balls adhering closely to one another, the whole looking, as to its form, not unlike a bunch of grapes. These are the eggs of the whelk. Each of the little balls

Whelks' eggs.

was once a tiny sphere of jelly enclosing an egg, but, since they were set floating in the water, these spheres, which were elastic, have swollen and stretched to their present size, hardening as they did so. The children will remember that frogs' spawn is protected in much the same manner, though in the case of the frog the encasing spheres remained soft and jelly-like.

The *cowry*, the pretty barrel-shaped univalve with its long narrow, notched mouth, is a shell which will interest the children who have heard of the use of cowries as money, and who, like the primitive grown-up folk in Africa, are fond of stringing them together as ornaments.

Let the children look about the beach for other univalves. They will find some like little pointed towers, some like armoured breastplates (chitons), some like long pointed teeth or tusks. On their return show them a specimen of the beautiful ear-shell (*haliotis*). Though it is only found in the Channel Islands, it is a frequent ornament in humble homes. It has a delicate, pearly lining, and rows of holes running along its broadest part, decreasing in size as they approach the top of the spiral. It is so flattened that it looks like part of a bivalve, but the children can trace the broad spiral which suggests the snail-shell type, and they can be told that the animal lives in the wide, shallow, pearl-lined cavity below.

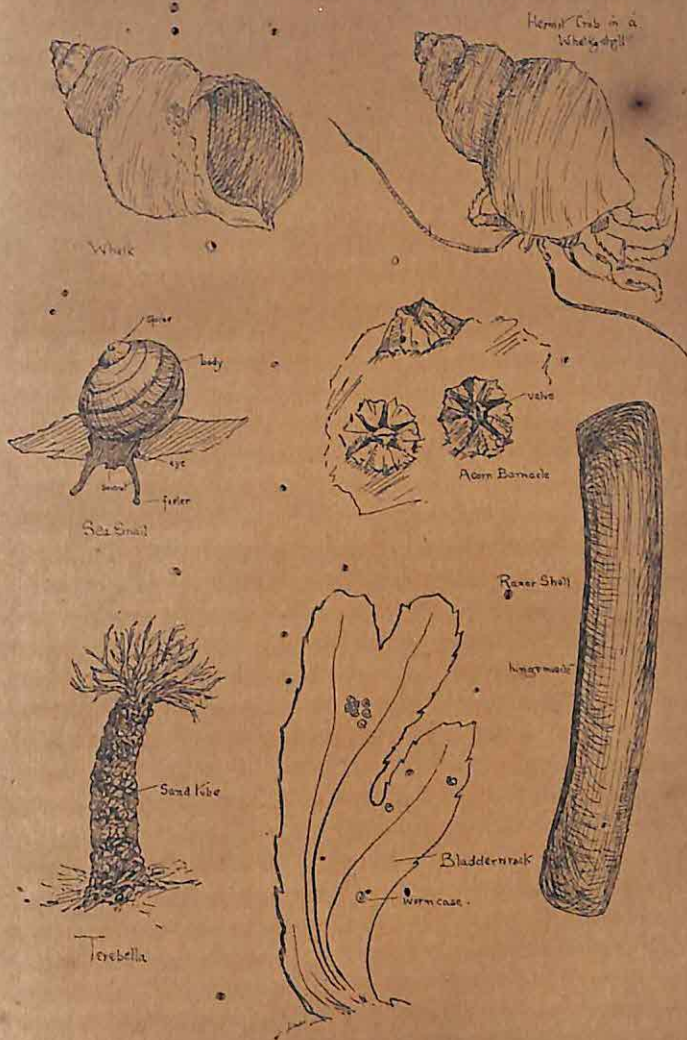


FIG. 43. — CREATURES OF THE SHORE

CHAPTER XXXIV

HOLIDAYS BY THE SEA.—(3) BIVALVES;
CRUSTACEANS

Shell-fish: Bivalves.—The oyster, which we took as a type of the bivalves, will not be seen alive upon the shore unless the children are taken to see oyster-beds, but they may find the half-shells, glistening with the mother-of-pearl secreted by the mantle, and may be told about the pearls of commerce.

Mussels will be found alive in abundance in vast black companies spreading over the rocks, the pier, and pieces of dead timber. Each mussel **Mussels.** fastens itself to its support by a cord of strong silken threads (byssus) which it spins out from its body near the hinge, so that it is moored like a boat to a landing-stage. The black valves show curved lines widening out from a kind of knob (umbo) near the hinge; this is the oldest part of the shell, which grows by adding wider and wider margins to those already formed.

The mussel does not seek its food like the whelk; it lives on tiny particles carried in the water, which enters the body by a small tube at the broad end of the shell, farthest away from the umbo. The water brings not only food but also dissolved air. Between the slightly gaping valves sharp eyes may note the pulsing movement of the frilled opening in the mantle through which the water is inhaled, and above it the siphon

tube through which the water flows out after it has passed over the gills and through the body cavity.

Some bivalve molluscs are more active in their habits than the oyster or mussel. On the shore the children will find the long curved narrow shells, coloured prettily in mauve, pink, or brown, which belong to the "razor-shell fish."

On the strip of sand left moist at low tide they will see holes showing the mouths of the burrows which the living creature makes for itself, with the foot and the sharp razor-like edges of the shell. Little jets of water thrown up from these holes show that the creature is "breathing" below in the same fashion as the mussel, taking in water and exhaling it when it has served its purpose (fig. 43, p. 247).

The cockle, an edible bivalve, well known to townsfolk and easily recognised by its heart-shaped shell, is also a burrower. Like the razor-fish it makes a hole in the sand; but it is a more active creature, for it can literally *skip* for some distance by sharply contracting its muscular foot.

Collection of shells.—The bivalve "finds" of the shore include the graceful scallop, whose pink and white ridges spread out fan-wise from its umbo, which is flanked by a kind of wing on either side; other shells of the same group as the scallop (*Pectens*), which are of a beautiful orange colour; the delicate "sunset shells," and many others. The children will not always obtain both pieces of the bivalve (the lower portion of the scallop, for example, is far less often thrown up on the beach than the flat, upper valve). Both teacher and children should make collections of shells; the teacher collecting as many of each kind as he has pupils in his class. In the dead season of the year, when living specimens are scarce, the little bags of shells will form delightful "observation" lessons of great value in

recalling what has been observed of adaptation to environment, and in training to appreciation of beautiful form—an appreciation which will be deepened by the exercises in modelling or drawing which will naturally follow.

On the rocks at low tide, or perhaps clinging to a cockle or whelk, will be found the tiny acorn barnacle, **Barnacles.** which seems to be neither univalve nor bivalve, but, multivalve—a flattened cone of shells. But this little creature, though it looks at the first glance something like the limpet, is not a mollusc at all; it is really a crustacean—a relation of the crab. It has six pairs of feathery, curved "limbs," which it thrusts out and then swiftly draws back. In this way it secures tiny particles of food. But the movement is so rapid that the best method of watching it will be to put the creature into a jar of clear sea-water and to lend the child a hand-lens (fig. 43, p. 247).

"A strange life history theirs," says Professor Arthur Thomson, speaking of these little acorn barnacles, "for they start as free-swimming larvæ, and after enjoying liberty for a time, settle down on their heads, and become surrounded with a castle of lime with four pieces of movable roof, and six side-pieces forming strong walls." Professor Huxley described the acorn barnacle as "a crustacean fixed by its head, and kicking its food into its mouth with its legs."

The ship barnacle, which fixes itself on the bottom of ships and may sometimes be seen on objects which have been floating in the sea, is a relative of this little acorn or rock barnacle, and differs from it not only in liking to travel, though without personal exertion, but also in having a kind of stalk below the valved "head."

A much more lively crustacean will be found as the children lift the torn-up strands of bladder-wrack or ribbon-like laminaria to search for finds along the

line of jetsam. They will be startled by countless little jumping creatures which were hiding among the wreckage under the weeds. These are the sand-hoppers—relations of the shrimp and crab, which are of great use in eating up fragments of decaying matter found among the jetsam, stripping away all the fleshy parts from the bodies of stranded sea-creatures and leaving clean white skeletons. The sand-hopper does not live in the water, but among damp weed and in damp sand. If one of them is taken on to the palm of the hand it will probably lie quite still for a little while, feigning death. Then it will suddenly double up its body, and straighten it out again with a jerk so rapid as to carry it out of the hand and on to the ground. On a moist sandy shore we find them hopping about in immense numbers. Even if the shore seems dry, by stamping the foot we can suddenly see openings in the yielding sand, which are the mouths of the burrows, where they hide.

As we find the sand-hopper doing useful work on the sands, so in the rock pools we are tolerably certain to find some specimens, at least, of his cousin **Shrimps.** the shrimp, who does similar service in the water, devouring the microscopic bits that would otherwise decay and help to render it foul. It needs sharp eyes to see the little shrimps, for they dart about very quickly, moving by means of strokes of their broad tails. Moreover, the brown or reddish colour which the children naturally look for in a shrimp is the result of boiling, and these live shrimps are pale and almost transparent. When at rest, they will bury themselves in the sand, with only eyes and feelers protruding, and it is difficult to find them. The prawn is larger than the shrimp, and has a prominent "beak" armed with saw-like points projecting from the head.

The children will see lobsters caught in the basket-

work traps which the fishermen set for them. When the lobster is in the sea it is blue-black; the red lobsters

Comparison with lobsters. that we see at the fishmonger's have changed their colour as a result of boiling. The children will readily see that the shrimp and the lobster are relations. Both have

five pairs of legs. In the lobster one pair of these is armed at the end with huge pincers, for attack or defence. The body is protected by a plated shield or "crust"; hence the name of the order, Crustacea. This shield or shell, as it is often called, is shed at intervals, and the animal has to hide in a safe place until the new coat hardens. Let the children note that the "shell" of these crustaceans is in this respect, among others, very unlike the true shell of a mollusc. They will be interested to know that the loss of a limb does not disconcert these creatures; if a leg is broken off they manage very well with the remainder, and proceed to grow another in place of the missing one. Both shrimp and lobster have five pairs of little appendages beyond the legs; these are used for swimming. Children often notice little bunches of eggs among the swimmerets of a shrimp; they can be told that the mother shrimp keeps the eggs there for safety.

A crab is not at first sight very like a lobster or shrimp. The plate which covers the body is very much broadened, and there would appear to be no tail. But if the creature be turned over—if alive, it should be picked up behind the great claws by the finger and thumb—it will be seen that the tail is there sure enough, but folded close against the under side of the body. The feelers of the head are relatively much smaller than those of the lobster or shrimp, and the eyes are on very short stalks. The crab which the children will most often find in or near the pools is the little green shore-

crab, with flat, fringed hind legs which are very useful to it in swimming about after its prey. Though on the sand the crab has a curious sidelong, scuttling walk, it is very agile; it will unerringly pounce on a living victim, tuck it into a kind of cage formed by its legs, which correspond to the bars of the cage, and use one of the big claws as a hand wherewith to seize its captive and convey it into its mouth.

Crabs, as has been remarked, are humorous-looking creatures, grotesque, with a touch of drollery about them. This is especially the case with the hermit crab. If a child looks into

a rock pool he may often see a whelk-shell with what looks like the legs and claws of a miniature lobster sticking out at the opening, the legs often actively in motion, and carrying the shell with them. These legs and claws cannot belong to the soft-bodied whelk, which, as we have seen, has no legs, but only a soft prolongation of the body—the foot. The original inhabitant of the shell has perished, leaving an empty house, and this has been taken possession of by the “hermit.” He differs from an ordinary crab in having long antennæ and long eye-stalks (hence the lobster-like appearance at the mouth of the whelk-shell), but chiefly in having no shield to protect the hinder part of his body. He is glad, therefore, to seek the convenient shelter afforded by an empty shell. If he is touched he draws back into the shell as far as possible, and one of the great claws, which is larger than its fellow, is used as a kind of bar to guard the opening. When the crab has grown so much that a new house is necessary, he merely looks out for another shell and “moves.” Thus the same “hermit” may inhabit many houses during his life, beginning with a little orange periwinkle, then passing to a small whelk shell, and shifting his quarters from time to time according to his growth (fig. 43, p. 247).

CHAPTER XXXV

HOLIDAYS BY THE SEA.—(4) BETWEEN THE
TIDE-MARKS

"OF all tracts on the 'habitable globe,'" says Professor Miall, "none so swarms with life as the beach a little above and a little below low-water mark." But the line of sandy shore between high- and low- water marks, which is nearly always accessible, is nevertheless rich enough to repay search at times when the farthest rocks cannot be reached, and the "finds" often serve to interpret a fragment of the abundant life which haunts the great wastes lying out beyond.

Among the jetsam we are pretty sure to find, besides weeds and whole or broken shells, fragments of sea-urchins, and specimens of dead starfish.

The starfish. This will be a good opportunity to examine the starfish. No child who has ever seen it will forget the five slightly curved rays or arms which practically form the so-called fish. The whole surface is studded with little knobs or spines, for this is one of the order of prickly-skinned animals (*Echinodermata*). Let the child lift up the creature and look at its under surface. In the middle he will find its mouth—rather a large mouth in proportion to the size of the creature. The reason for this is that the starfish lives on small bivalves, and swallows them whole, digesting the soft bodies and then throwing out the empty shells from the mouth. Along the under side of each ray is a

groove, and within the groove are rows of tube-like suckers or "tube-feet." The living animal when at rest keeps these drawn within the groove, but it can thrust them out at will through rows of tiny holes and thus move slowly along. If the child finds a live starfish in a pool he may gently turn it over and watch it regain its position by the help of these delicate tube-feet, looking like silvery threads with knobs at the end of each (fig. 44, p. 259).

A relation of the starfish is the sea-urchin, so called because, like the backboned land "urchin" or hedgehog, its body is covered with spines, which, however, in the dead specimens found among the jetsam, are often broken off by the waves. The spines project from a hard, chalky, globular case, which covers the body of the creature except for the rows of holes through which it thrusts out sucker-like feet resembling those of the starfish. Like the starfish, too, it has its mouth on the under side of its body. A sharp child of twelve will be delighted to cut out in paper a five-rayed starfish, mark the upper and lower surfaces in different coloured crayons, make a wide circle on the under side for the mouth, make grooves with the point of a pin along each arm on the same side, turn all these five arms upward, and unite them at the top to form a hollow sphere. Then, if he will imagine the whole enclosed in a spiny case pierced in double rows to correspond with the grooves, he will have the "build" of the sea-urchin, as far as the outward parts are concerned, and will realise how, in spite of their apparent unlikeness, it is very similar in structure to the starfish. The sea-urchin has a comical habit of carrying on its back shells, stones, and bits of weed which it has picked up with its tube-feet, and it is an amusing creature to keep in an aquarium, where it may be fed on small pieces of fish. Other

relations of the starfish are little brittle stars sometimes found in the pools. They have five long slender rays, which break quite easily of their own accord when only very gently touched, so that it is rarely that a perfect one can be secured. But the starfish family suffer no inconvenience from mishaps of this kind; they speedily form new members to replace any that they may have lost (fig. 44, p. 259).

On the sands the children will find numbers of stranded jelly-fishes (*Medusæ*). They are rather sorry objects in this condition. If one is picked up, the yielding jelly-like mass slips in fragments between the fingers. If a fairly perfect one is found, its shape will be something like that of a mushroom, with red or purple lines radiating from the centre. It may be gently turned over, and underneath, in the same position as that of the starfish, will be found the mouth, surrounded by its ribbon-like feelers. If we leave the creature lying in the sunshine we shall find, on returning in a short time, that nothing is left of the mass but a whitish rim marking the outline of the body; for the substance of the jelly-fish is nearly all water, which has evaporated in the heat.

It will be a pity if the child should have no better notion of a jelly-fish than is afforded by these unsatisfactory dead specimens. Bid him, if he is taken out in a boat, look down into the water and watch for beautiful crystal umbrellas floating up and down in the waves. Graceful fringes hang from the rim of the umbrella. These are tentacles, which, by-the-by, are provided with cells from which little stinging whips can be thrust out at attacking animals, and of which most bathers have some unpleasant experience to relate as a result of swimming against these almost invisible fairy umbrellas. It was these rim-tentacles, hanging down like hairs or snakes, which suggested the name

"Medusæ." Where the handle of the umbrella should be there are four waving streamers. These are really four long protruding "lips," which surround the mouth and draw the prey inwards, stinging it to death at the same time (fig. 44, p. 259).

A floating jelly-fish, with its frond-like streamers, is not unlike some fantastic flower; indeed, one of the pleasing puzzles of the seashore is to determine whether a given object is animal or vegetable. On the beach will often be found tufts of what is apparently a brown seaweed, not unlike sandpaper in appearance and in texture, marked all over with little pits. This is a sea-mat, or flustra, which is not a seaweed, but represents an animal colony. Each member of the

The sea-mat. colony, with a body and tiny tentacles of its own, inhabited a little hollow cell in the "mat." The flustra when living is a mass of cells. When dry, the front walls of the cells collapse and give the appearance of pits. The children may perhaps know that an ordinary sponge is the skeleton of what was once a colony of still more lowly animals, and on the sides of the rock-pools they may find small sponges still carrying their colony of living animals, which have the appearance of mere structureless masses of jelly.

Other forms which have some resemblance to plants occur in some of the worms that live on the shore.

Worm-cases. These live in tubes of sand and broken shells which they make for themselves, gathering the materials with the long feelers that form a fringe at the upper end of the body. Empty cases are very often found lying on seaweed or on rocks, but the worms themselves may be found in rock-pools and taken to the aquaria, where they must be supplied with freshly gathered seaweed in order that they may obtain their food from the microscopic bodies

which such vegetation generates in the water. It is very interesting to see the long tube standing out from a bit of rock with a tuft of sensitive filament crowning its open end—the tube and tuft reminding one of a stalk with palm-like foliage. Sometimes, however, the creature draws back the feelers into the tube and closes the opening with a kind of knob (fig. 43, p. 247).

The little twisted tubes often found crowded together on seaweeds are also made by worms. The tube is coiled prettily, like a post-horn, with a space left in the middle, so that it may easily be distinguished from a snail-shell (fig. 43, p. 247, Bladderwrack).

The worm whose castings are seen on the shore is the lobworm—a long red-tufted worm which the fishermen dig out for the bait. He swallows the

The lobworm. sand for the sake of the tiny particles of nourishment it contains, just as the earth-worm swallows the mould in the fields. He burrows quite a long way down, lining the tunnel with slime from his body to prevent the sand falling in on him.

Among the curious "finds" of the *débris* is the sea-purse, or mermaid's purse, of which there are two kinds. One is a dark-brown oblong case, **Sea-purses.** tough and leathery, with tendrils at the four corners. This is the egg-case of the dogfish. The tendrils are useful for twining among weed so as to keep the eggs in a safe place until the young can escape (fig. 44, p. 259). The other kind of "purse" is similar in shape, but nearly black, with inch-long spines instead of tendrils at the four corners, so that the whole structure looks something like a miniature hand-barrow. This is the egg-case of the skate—the skate's barrow as it is sometimes called. In spring or early summer it contained the young fish, which has by this time burst its way through and escaped to the open sea.

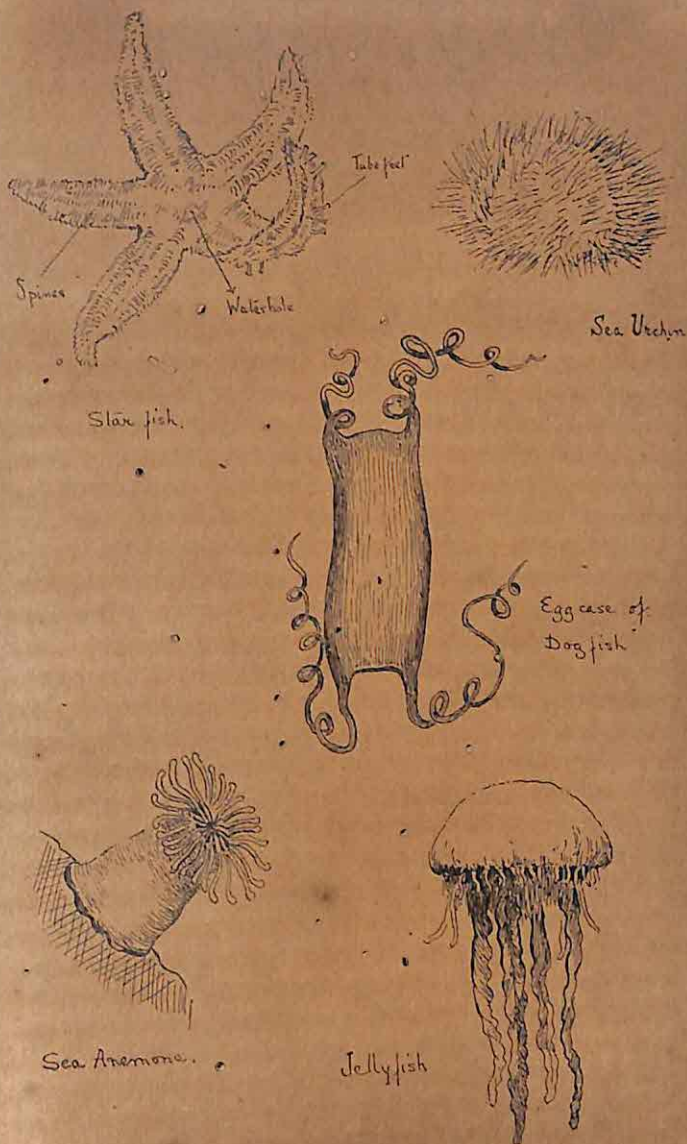


FIG. 44. - CREATURES OF SHORE AND POOLS

CHAPTER XXXVI

HOLIDAYS BY THE SEA.—(5) BY THE ROCK-POOLS

THE pleasures of picking up treasure-trove on the beach, great as they are, must pale in comparison with the delight of a visit to a rock-pool. The children will set off at low tide with bare feet, loose sleeves, or bare arms, each with a couple of pails or glass pickle-jars in which to bring home their "finds," and perhaps a penny gravy-strainer or a muslin bag with wire round the open mouth and fastened to a stick. They cross the wet, yielding sand and come on to the weed-covered rocks, where they must be careful to avoid slipping. When they are some way out they can begin exploring the little pools or fissures. The commonest weed is the coarse fucus or bladder-wrack, though nearer the low-water mark they will find the long, smooth, brown ribbons of the laminaria. They must very gently lift up the hanging weeds and look and feel along the sides of the rock. Clothing the sides they will find beautiful purple and bright green weeds. The most common is the ulva or sea-lettuce. Let them watch for the curious little sea-snails feeding on these, and notice the shape and marking of the shells, the odd little snout-like head, and waving feelers. Little crabs will be swimming through the pool or scuttling away across the sand. If we gently lift up the stones lying in the bed of the pool we shall probably be rewarded by seeing some little creature who had been hiding there dart forth into the clear water—a crab, a crayfish, a pale sand-

coloured skrimp, possibly a little fish—a skate or rockling. Close against the sides or on the floor of the pools groups of starfish will be sprawling, and the tube-worms will be waving their delicate filaments.

Some of the “weeds” clinging to the sides of stones—jointed tufts of pink or purple—are not vegetables at all, but animal colonies, congregations of tiny polyps, or jelly-like animals, each consisting practically of a mouth fringed by tentacles. Tiny sponges, made up of similar colonies, will also be found clinging to the sides of the pools, looking like fragments of brown slimy stems.

But the most flower-like of all these inhabitants of the rock-pools is, of course, the wonderful sea-anemone.

The children will find beautifully-coloured circles of rays round a central disc, the fringing rays spreading out like the petals of a chrysanthemum. The commonest colours are crimson, green, reddish-brown, and pink. One kind, with red-brown “stalk” and pink rays, has a row of blue beads between the rays and the rim of the stalk. This is the Beadlet Anemone. The petals are the tentacles. And in the disc in the centre is the slit for the mouth of the creature, and the “stalk” of the apparent flower, by which it is fastened to the rock, is really the double bag which forms its body. It holds to the rock by the large sucker-like base of this bag. The other or open end is the mouth. The petal-like feelers are used to draw into the mouth any food that floats towards it—a shrimp or a bit of dead fish. If we touch the creature with a hard substance it will draw in these rays so as to look like a mere bag of drab-coloured jelly (fig. 44, p. 259).

By good fortune one of these anemones may be found fastened, not to a rock or stone, but to the outside of a whelk-shell which is tenanted by a hermit crab. The shell has one lodger within and another on

its roof, as it were, the anemone having settled down there on its broad base. This is an advantage to the crab, for the rays of the sea-anemone, like those of the jelly-fish, are provided with stinging-cells, which cause them to be avoided by fish who would otherwise attack the crab. The anemone profits in its turn, for when the crab makes a meal some of the bits are sure to float upwards in the water, where they can be seized by the anemone's tentacles. In an aquarium we should feed the crab first, or it will rob the anemone, which will then close up for some time.

The charm of the rock-pool may be in some measure imitated in an aquarium. In a school several bell-jars or small tanks are probably preferable to one large tank, and thus the creatures which would prey upon one another can be more easily kept apart. We have already mentioned that the bottom of the aquarium should be provided with fine sand, bits of rock for hiding-places, and a supply of weed to keep the water aerated. From the pools the children may bring home sea-anemones (sometimes a sharp knife will be needed to break off the bit of rock to which they are fastened), starfishes, molluscs, and crabs. All these may be conveyed in damp seaweed; for the shrimps they will need a jar of sea-water. The little penny "guide" before mentioned will tell what is to be done in the way of food and shelter for the different creatures and for the aeration of the aquaria.

A word must be said about the birds of the seaside. On the cliffs above, starlings, jackdaws, sand-martins have built their nests earlier in the year, and still fly about their old haunts. On sandy stretches at low water we may notice the tiny footprints of the sandpipers or dunlins, while the birds themselves float idly on the incoming waves

Sea-anemone and hermit crab in partnership.

Aquaria.

Birds of the seaside.

or paddle about on their stilt-like legs in the shallow water.

Sea-gulls skim above the waves, ride on their crests, or wheel and hover in the air, making the most beautiful curves in their flight. The town child has perhaps seen some of these gulls in winter on the Thames, and the country child has seen them on the ploughed fields. But the wide expanse of the sea seems the fitting setting to the bold, free curves of their movements. Sometimes they settle in flocks on the sands or descend upon a shoal seeking for the bits of waste substance which form their food.

At least once before leaving the seaside the children may coax their elders to take them down to the shore

Phosphor-escence. in the late evening so that they may see the glow of phosphorescence along the line

of wet jetsam, on the waving vegetation in the pools, in the wake of a moving boat, or dripping from lifted oars. It gilds the restless sand-hoppers, and scatters like jewels from a handful of wet shingle. It is difficult to explain this to the children, but they may be told that the light is given off from the bodies of innumerable tiny creatures living among and on the weeds and in the water. And they will be delighted with the incantation used by a child friend of the writer, an incantation which also involves a pleasing puzzle in spelling :

Phosphoresce for us, dear Sea ! Phosphoresce for us !

CHAPTER XXXVII

A CORNFIELD AND ITS INHABITANTS

THOUGH harvesting is much less picturesque nowadays than in the old times when the corn was cut with sickles by hand and the women and children gleaned after the reapers, yet a cornfield is always an attraction, and always awakens a sentiment unlike that produced by the sight of other food crops. This attraction is partly due to the charm of colour and movement, for the rich golden-brown of the corn and the long ripples of an uncut field always invite the eye; but more perhaps is due to an inherited reverence for the gift of grain—a reverence expressed in the thanksgiving for daily bread, in harvest festivals, and in the old myth of Ceres.

Corn: A generic name.—It is worth while letting the children note that the word "corn" is a general term used to cover different kinds of grain crops. The commonest corn grown in England is of course the wheat, but oats, rye, and barley are also found. It will be an interesting study for the elder children to compare these common kinds. We have already suggested that specimens should be grown in the school garden.

Wheat.—The flowers of the wheat are so inconspicuous in colour and so minute in structure as to escape an unobservant eye, but they are not too small to be made out by an attentive child, and they are so

exquisite in structure as to be worth the patience and trouble. The flowers grow on tiny spikes packed closely

Flowers round the stem, and are protected by
and fruit. scales. On removing the outer scales from

one of these flowers we find within another scale shaped like a tiny boat, keeled with a very sharp awn, and fitted with a movable deck formed by another scale. In the hollow of the boat lies the tiny seed-case, with plummy stigmas hanging out. The children will hardly be able to avoid rubbing off the slender anthers, evenly poised on thin hair-like filaments, which hang out from the covering scales. After fertilisation has taken place in the manner described in the lesson on grasses, and when the seed has been set, the stamens and the feathery stigmas shrivel and wither away, and the green seed-case which lies within the scaly bract grows until it becomes the hard, yellow, grooved wheat-seed which forms the precious cargo of the little boat, filling all the hold. The children will be familiar with the wheat-seed from their experiments in germination; now they may notice how the boat and its deck are loose and can be easily removed as "chaff."

In the barley the keel of the boat—the "awn"—is as long as the whole ear, and the grains are laid neatly
Barley. side by side in two rows along the central stem, whereas in the wheat they are more irregularly crowded. There is a kind of wheat which is "bearded" like the barley, but it can easily be distinguished by the blunter fruits and shorter awns.

The rye is somewhat like the barley, in that the
Rye. fruits, which are slender, small, and pointed, are arranged in neat rows, but the awns are very much shorter. Rye, by-the-bye, is reaped earlier than other kinds of corn. The oats are

more irregular ; the central axis has numerous branches, which branch and branch again so that they dance loosely in the wind, lightly weighted with the long, sharply-pointed fruits.

The children will see that the wheat is a big grass



FIG. 45.—WHEAT



FIG. 46.—OATS

plant. Like a grass, the green leaf-blades show themselves first, then the hollow, jointed flower-stalks lengthen above the leaves, the little stems and roots. flowers hang out stamens and pistil, and finally the firm fruit is formed and ripens.

"First the blade, then the ear, then the full corn in the ear." All this time the fibrous grass-like roots have been spreading underground—extracting from the soil the nourishment necessary for the plants, including



FIG. 47.—RYE



FIG. 48.—BARLEY

the tiny flinty particles (silica) which make the stems so hard, and brittle. The elder children will be interested to picture the great length of these fibrous roots. Though they do not penetrate more than eighteen or twenty-four inches into the soil, yet they are so many that a German observer gives the total length of the roots of a wheat plant as 568 yards.

Enemies of the wheat.—But the wheat has animal and vegetable enemies both above and below the soil. Perhaps the most deadly of the animal foes is, the wireworm, which is not a worm at all, but the larva or grub of the "skip-jack" or "click" beetle. The beetle has these names because it presses its head against the ground, forms its body into an arch, and then makes a spring, producing at the same time a curious clicking noise. The eggs are laid at the root of the wheat plants, where they hatch out into hard, shiny, wiry grubs, with six horny legs in the forepart of the body. They live three or four years in the grub stage, feeding all the time—except during the cold winter months—upon the roots of the wheat, causing the plants to fade and turn yellow. It ought to be strongly impressed upon country children that the best means of getting rid of wireworms is to encourage the rooks and starlings, who dig for and devour them.

Above ground, the plant is attacked by wheat-midges. The perfect insects are very small, pale orange-coloured flies, who lay their eggs among the florets of the wheat while it is flowering, so that the little maggots, when they are born, begin at once to devour the grain.

Rodents and birds.

The attacks of the larger animal foes, rabbits and nibbling mice, and birds who help themselves to the sown seed or to the ripening grain, are far less formidable and more easily dealt with

than these hordes of insects whose numbers make them so difficult to attack.

Then there are vegetable foes—the wheat-rust—a tiny fungus which settles on the stems and blades and destroys that “living green” which is necessary for its life; and the manifold “weeds” of the cornfield, some of them very beautiful in themselves, but disliked by the farmer because they drain the ground of the nourishment needed by the wheat, or prevent it from having light and air above.

Among the most beautiful of these is the corn-flower, with its deep-blue pennons hung out to attract flying insects, and its stiff palisade of bracts to keep out crawling ones who would ascend the stem from below. This flower is so beautiful that it has been transferred to gardens. Another weed of the cornfield—the poppy—has had a similar destiny, and in the gardens of the vicar of Shirley, in Surrey, and elsewhere, new and beautiful varieties have been produced. But the colour-charm of the wild poppy still stands unrivalled; nowhere is there to be found so intense a scarlet. The poppy is delightful in other respects also; the children will be very pleased to note the falling-off of the green calyx cap as the crumpled scarlet petals break through, and later they will like to see the beautiful capsule with the projecting eaves of its roof covering the little holes through which the innumerable tiny seeds are swung out when they are rocked by the wind. The scarlet pimpernel, which shuts up early in the afternoon, about 2 P.M., so regularly as to serve as a clock to the outdoor labourer, is an inhabitant of the cornfield; so is the lesser convolvulus or black bindweed (*Polygonum convolvulus*), which twines its slender stems round the corn-stalks and lifts up its pale pink chalice as it climbs. Whereas the large white convolvulus or “bindweed” of the hedges turns from right to left, this

little convolvulus always turns from left to right. In both cases the twining is effected by a revolving movement of the growing part of the stem. Let the children compare its behaviour with that of other climbing plants in the fields—the little vetches, for example, which climb by tendrils. The camomile, the yellow ragwort, and the little crimson-flowered knot-grass (which is not a grass at all), charlock and dock are among the other “weeds” of the cornfield. But in spite of all these enemies, animal and vegetable—“a whole world as it were let loose upon the wheat to eat, consume, and wither it, yet it conquers the whole world” (R. Jefferies). And after withstanding so many attacks, the corn is cut and bound into sheaves, and the fields are laid bare.

Birds who live in the cornfield.—Now is the time to realise all that the forest of blades and stalks has hidden. There will be the empty skylark's nest. The skylark always builds upon the ground, and by some instinct prefers the midst of the cornfield, where passers-by will not disturb the nest of the young. “Every blade of corn,” says Jefferies, “has been sung over by a lark.” But now the broods of many homes have been reared and the nests lie empty. The partridge, too, may be seen flying from the fields with her young. She is a round, plump bird, with short wings, with which she can fly rapidly, though not very far. Early in the year she laid, perhaps, as many as twelve eggs, and now that they are hatched, and before the field is reaped, they follow her in a “covey,” to the bean-fields or cabbage-fields. If they haunt the stubbles later in search of grain, they will, alas! fall victims to the “sportsman's” gun. The harsh cry of the corn-crake, something like the noise of grating machinery, is often heard in the cornfields at dusk.

The harvest-mouse.—Among the sheaves the field-mouse is busy. In our lesson on hedges we have

noticed the different kinds of field-mice. The nest of their relative, the harvest-mouse—the midget of the mouse tribe—was built in the corn-stalks and has been cut down with them. Though the children will rarely see a harvest-mouse, there will be a specimen of the dainty little creature and its nest in every museum, and their knowledge of the house-mouse will form a point of contact. It is worth while reading to them the account given of it in Douglas English's "*Wee Timorous Beasties*," and showing his photographs of it. It is little more than two inches long from its nose to the tip of its tail. Mr. English, who kept harvest-mice as pets, found that ten of them would pack into a cocoa-nut shell less than three inches every way, and sit there contentedly for hours. Out in the harvest fields they make nests in the corn-stalks about a foot from the ground, using the leaves of the corn, which they bend and twist so as to make a lofty cradle for their young. A harvest-mouse holds on, not only by his feet, but by his tail, which, unlike that of any other British mammal, is truly prehensile, a clasping organ which forms a spiral round the corn-stalks and thus enables him to swing there at ease.

Winged gleaners.—The stubble fields are haunted by multitudes of birds. Not only birds of the countryside, but town sparrows also migrate in flocks to the standing sheaves and the yellow stubble, for, even in spite of modern machinery, countless grains escape the hand of man. Then there are the seeds of the "*weeds*," and the multitudinous insects that the tall stalks sheltered, so that every kind of bird can pick up a meal. "Every one of the multitude has a keen pair of eyes and a hungry beak, and every single individual finds something to eat in the stubble."

CHAPTER XXXVIII

THE GARDEN IN LATE SUMMER

Its colouring.—When the white, pink, and blue flowers of the garden begin to give way to the yellow and the red, the children will know that summer is drawing to a close. But perhaps at no other time of the year is the primitive colour-hunger of the child—the instinctive taste for strong, bright, clear hues—so abundantly satisfied. Beginning with the calceolarias in July we succeed to the yellow of the sunflowers, the nasturtiums, to the evening primroses, and the Shirley poppies. The red comes with the geraniums, the poppies, the hollyhocks, and deepens in the dahlias. Then the colour-scheme of the year declines more soberly through the asters and chrysanthemums to the neutral tints of winter.

The late summer, too, is the season of *tall* flowers: the sunflowers, hollyhocks, dahlias, and evening primroses are the giants of the beds and borders.

Earwigs.—The children will find the dahlias infested by earwigs; these are only attractive to the advanced student, who will be delighted with the beautifully elaborate folding of the wings and with the care, singular among insects, with which the mother earwig tends her young. Little children should be told that earwigs do not attack their ears; they much prefer little tubular shelters such as are afforded by the funnel-like petals of the dahlias; and knowing this, gardeners often set traps for them made of straws and hollow bean-pods placed under flower-pots.

The Evening Primrose.—The evening primrose is a specially interesting flower. A child may watch it just before bedtime to see how suddenly a blossom will open, the sepals falling back and the pure yellow petals disclosing themselves in a few seconds. Though the blossom opens in the evening, yet once open, it remains open for the following day also. The evening primrose has plenty of honey, and is visited by night-flying moths who are attracted by the pale yellow colour.

Invite the children to look round the garden and take stock, as it were, of its contents. The end of the summer does not mean the end of the garden. How is it to be maintained another year?

Annuals.—They will see that some of the plants sown in the spring have blossomed, shed their seeds, and died. Their life is over with the summer. Such are sweet-peas, cornflowers, sunflowers, love-in-a-mist (*Nigella*), ten-week stocks, nasturtiums, mignonette. These are called "annuals"; we must pull up the dead annuals by the roots and preserve their seeds for another year.

Biennials.—Some plants, such as evening primrose, sweet-william, foxglove, Canterbury bell, are biennials, having a life of *two* years. If any of these plants are blooming in the garden this year we know that it is probably the second year of their life. During the first year the plant as a rule forms only a short stem with leaves, though sometimes, if the season is very mild, it will flower in late summer, in advance, as it were, of the next season. The leaves work for the plant and store up food for it in the roots or stem. In the second year the main stem lengthens out and bears upwards its buds, which open into flowers and at last form seed. This is the crowning act in the life of the plant, and now it begins to decline and die.

It is in the kitchen garden, of course, that the children

will find most striking illustrations of the stages of a biennial. If we gather a carrot, a turnip, or a beetroot we are taking for ourselves the stock of food which a biennial plant has stored up during the first year of its life in order that it might have a reserve from which to feed its growing buds in the second year. In order to get seed some of these have to be left to behave as Nature intended: the rest we take for food. Let the children look at a carrot. There is the well-known portion that we eat, tapering downwards and giving off slender rootlets. The main root has been converted into a store-house, as is the case also in the turnip and the beetroot. Let them notice the top of the carrot or "crown" from which the feathery leaves arise. This "crown" is really the flat undeveloped stem which has fused with the root. Children are fond of cutting this top off, piercing holes at the side, hollowing it out so as to make a little cup, hanging it up by strings through the holes, and watching the beautiful growth of leaves which it produces. These leaves will not grow from the lower portion of the carrot, which is the root.

Perennials.—There are plants which have a longer life and continue blooming year after year. Trees and shrubs are perennials. In our gardens we have herbaceous perennials—*i.e.* long-lived plants with soft foliage which dies down every year. A few of them, such as pinks, carnations, saxifrages, and some kinds of wallflowers, keep their leaves and may be called evergreen perennials. Most of them, however, appear to be dead, though they are only dead as far as the parts above ground are concerned, for next spring the roots will send up new stems. Among the most familiar of these are the hollyhock, Japanese anemone, antirrhinum (snap-dragon), columbine, larkspur, everlasting pea, lupin, lobelia, primrose, polyanthus, London pride, violet. The wallflower is sometimes classed as a

perennial, but it is really a biennial, and declines greatly after the second season.

How plants are propagated.—During the course of the summer the children will have seen how plants have been produced from seeds. The seeds of certain annuals—*e.g.* poppies—are to be planted in the autumn. In the spring they saw that a plant could be nourished on the store of food contained in a bulb. The bulb saved during the summer will now be planted so that we may have winter blooms. In both these cases two conditions were present :

Conditions.—1. There was a *live* portion of a plant having power of growth—the embryo of the seed, or the bud among the scale-leaves of the bulb.

2. A sufficient stock of food to nourish the new growing parts.

They will be interested to see how other methods of plant renewal can be used if only these two conditions are present.

Thus at the end of the summer we take cuttings of our roses, geraniums, and fuchsias. This means that we select a good healthy stem, cut it off, and plant it in the soil. Detached from its parent plant, it will make an effort to save its life by growing new roots for itself from the material contained in the tissues of the stem. If it succeeds, it will become an independent plant. Thus we may get “new plants from old pieces.” A piece of watercress in a bottle may be *seen* putting out these new roots. In the case of the geraniums and fuchsias the cuttings must be kept indoors during the winter, for they are not natives of this country. They are *half-hardy* perennials. Hardy perennials, such as Michaelmas daisies, snapdragon, and dielytra, may be left out of doors all the year round.

Some plants make new ones by running their stems along the ground, then striking down of their own accord into the soil, and forming fresh roots. Brambles, strawberries, gooseberry and currant bushes do this. The gardener takes advantage of this habit in reproducing certain other plants—*e.g.* carnations. He bends or layers the stem down, giving it a little kink and perhaps pegging it into the soil at the knots until it has struck root.

At the end of the summer some potatoes are taken up and "saved for seed," as people say, though they make no seeds at all. Let the children look at the "eyes" of the potato. The potatoes are put in a dark place and by-and-by they begin to sprout. It will be seen that these green sprouts lengthen out from the eyes, and that at the "eyes" in very young tubers a little scale-leaf can be found. If a thread be wound round the potato so as to pass through the eyes, where it can be secured by pins, it will be seen that the thread forms a spiral such as we found on the budding twigs of some trees—the oak, for example. The eyes are buds. Let the whole plant be examined just as it is taken from the ground. The potato cannot be a root, for we know that the eyes will give out green branches, and green branches are not usually given off from roots. The tuber is really the swollen end of the underground branch of a stem, and the swollen portion serves the same purpose as that served by the bulb—*viz.* to nourish the plant while it sends up the shoots that are to bear flowers. We must be careful not to break the green "spears," as the Kentish people call them. In the spring, the potatoes are cut up into pieces, and each piece having a good, vigorous sprouting "eye" is set in the ground where it will form a new potato plant. These "seed" potatoes, as we have

said, are not "seeds" at all, but they are like seeds in that there is a store of food ready in the tuber for the baby plant.

Perennial plants are often thinned out by dividing them at their roots. Thus the iris grows with a stout root-stock, which sends up long sword-like leaves and flower-stalks in clumps (*vide* p. 282).

When a clump grows too thickly, fresh clumps can be made by dividing them, moving a portion of the roots.

Dahlias and peonies have swellings on their roots resembling tubers: they are not true tubers, for they have no eyes or buds; they are merely root-store-houses.

Thus a new plant can be raised from almost any part of an old one. The swollen buds of a lily (bulbils) will drop to the ground and give rise to a new lily. And it will be an interesting experiment to show that a plant can be raised even from a leaf. The foliage leaf of a pelargonium or a begonia is so fleshy and rich in food that a portion of it will strike roots and eventually make a complete plant.

So, then, Nature makes abundant provision for the continuance of plant life in our garden. The question of life is bound up with the question of food. Her usual method, of course, is to start the new plant with its supply in a separate storehouse—the seed. But it is well that the children should realise the manifold resource of Nature; she is not bound to any one method. When one season has passed, the life of the next has been foreseen and arranged for in the infinitely various order of Providence. Cowper is an old-fashioned poet now, but his sober yet glowing couplets can scarcely be improved upon:

The beauties of the wilderness are His,
That make so gay the solitary place
Where no eye sees them. And the fairer forms
That cultivation glories in, are His.
He sets the bright procession on its way
And marshals all the order of the year ;

And ere one flowery season fades and dies,
Designs the blooming wonders of the next.

CHAPTER XXXIX

BY PONDS AND STREAMS.—(I) WATER PLANTS

WE have supposed the children to visit ponds and streams early in the year to search for frogs' spawn or tadpoles. But the side of a pond or stream will be an attractive haunt all the year round, for, as we have remarked, the love of water, whether merely a bright, rippled surface or a moving mass of stream or wave, is one of the primitive instincts of human beings. An interesting form of Nature study deals with such questions as: "Where does the stream come from? Where is it going? How came the pond in this corner of the field? How is it filled?" Young Londoners can be taken to Hampstead Heath and shown isolated ponds, chains of ponds, and the rise of a miniature river—the **Origin of Streams.** Fleet—with its tributaries and their watersheds. It is a little disappointing, of course, to find that the stream disappears into an underground sewer after leaving Hampstead, but, fortunately, the busy Fleet Street still preserves in its name a record of where this little stream once flowed into the Thames near Blackfriars. A school journey which has for its object to trace the source of the local stream or river will be an unforgettable experience. Perhaps the next best thing is a model in clay or plasticine, with layers of sand above clay in the highest part, on which a realistic shower may be made to descend through the rose of a watering-can. The writer has seen children of seven or eight follow with intelligent delight the history of a

river as demonstrated on such a model. But the model, when shown in city schools, should be used in conjunction with pictures, for while it explains the *why* of a river satisfactorily, it does not show to a town child what the stream looks like, say, at the Seven Springs in the Cotswolds, by the Oxford meadows, or under Cliefden Woods.

Ponds are formed in various ways, which may be made intelligible to children. A reference to puddles in the roadway shows that rain-water collects in any chance saucer-like hollow on the earth's surface. Such hollows are scooped out in the course of time by the action of wind, water, and frost, or they may be formed by slight subsidences below the surface. Often the surrounding slope is so slight as to be almost imperceptible; nevertheless, the hollow is there, and not only is the rain caught and retained, but the slopes drain their moisture into it. Thus a pond is formed. Occasionally, of course, the owner of a pasture where there is no water supplied by natural means will cause a pond to be dug out in the lowest part of his field. Ponds are most abundant on clayey soil, for, as the children know by their experiments with clay, this is a comparatively non-porous substance.

Sometimes a spring will gush up into a natural hollow and form a little lake, which usually finds some outlet in a stream. Some of the Hampstead ponds are fed in this way, the surplus water being now carried off artificially. Or a river in its course will scoop out a deep cup-like hollow in its bed, when it forms a *pool*. When the depression is shallow, it will spread out into a marsh. If, now, men drain the marsh, throwing dams across part of it, the swamp is converted into a lake or pond. The chains of ponds in the course of the Fleet River at Hampstead were formed in this way by

making embankments across a swamp and guiding the flow of the water in definite channels from one to another. The children may note, however, that the term *pond* is usually limited to a small sheet of water with no outlets. They should be led to see that the ultimate source of supply for all these water-ways and reservoirs of water is the rain from the heavens.

Plants of the waterside.—The children will hardly help noticing that the plant-life of ponds and streams is different from that of the down or hedge or field. Thus there are certain kinds of trees which are specially to be noted as water-lovers—the willow, with its long drooping branches and narrow pale green leaves, showing white on their undersides; and the alder, which can always be recognised by the small black cones that linger on its boughs throughout the year. The line of a dry stream or of underground springs can often be traced by these trees.

Wild-flowers of the water-side. Certain wildflowers must be looked for only by stream or pond side. The children may begin a list of these early in the year, by noting the glorious marsh-marigold—a relation of the buttercup, with its great golden flowers and broad leaves. In the early summer there will be the paler gold of the water-flag or iris, with its stiff, broad leaves and its golden six-fold perianth, three pieces of which hang down and three stand up. The fringed petaloid stigmas of this flower are always interesting to children, and its purple cousin will be familiar to them in gardens.

The water forget-me-not can be gathered by them at the water's edge, and later on in the year they may find the deeper blue flowers of the brook-lime. In the summer months, too, they will hardly fail to notice the meadow-sweet, a tall plant, 4 feet high, with a profusion of creamy white blossoms like those

of the garden spiræa, of which it is a relation. Unlike the spiræa, it has a delightful fragrance—hence

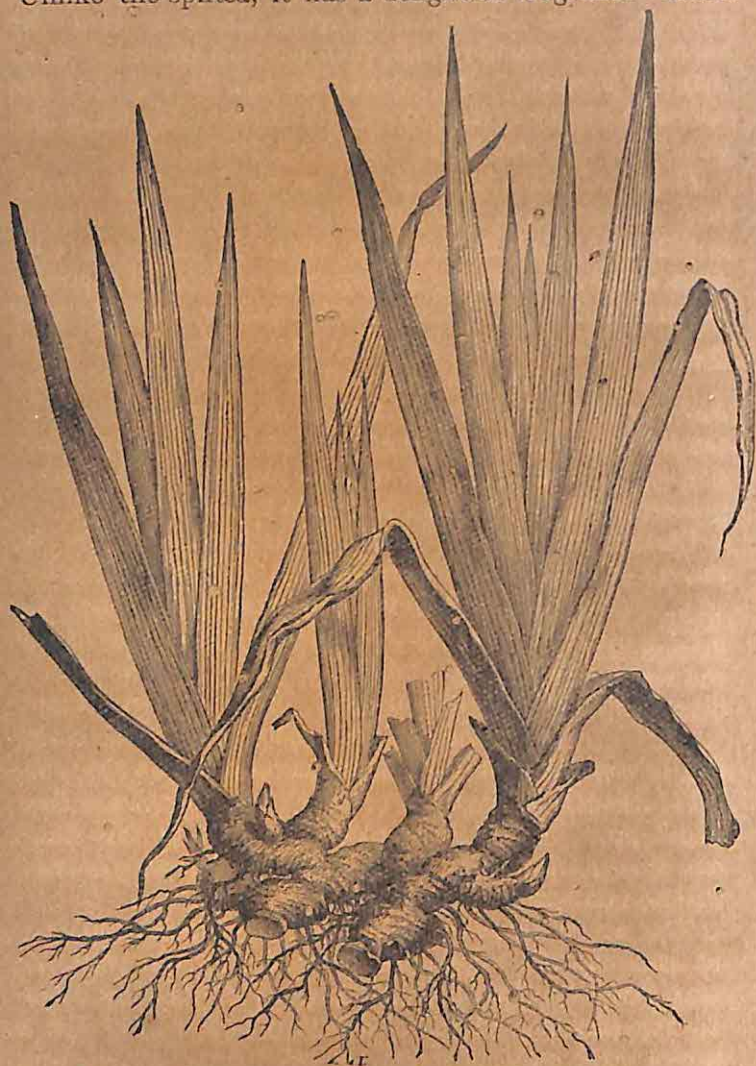


FIG. 49.—IRIS OR FLAG PLANT, SHEWING ROOTSTOCK

(*Vide pp. 277, 281*)

its name. Tennyson's "fairy forelands set with willow-weed and mallow" may also be re-discovered by young explorers. The burweed, water plantain, and mare's-tail are less showy, but common everywhere.

Areas of water-plants.—The children should be set to notice that whereas some plants merely like to be *near* the water, others adapt themselves still more completely to watery conditions. The following areas of aquatic plant-life may be distinguished:—

(1) Plants of the waterside; (2) plants that grow in the shallower parts of the water near the margin; (3) plants at the *surface* of the water; (4) plants that live below the surface.

Plants just within the margin.—Of the plants that live at the water's edge—knee-deep, as it were, their roots in the shallow mud towards the margin—the water-flag is an example. Here, too, in wild ponds and quiet backwaters, we shall find rushes, sedges, and reeds. These plants are often mistaken for one another, but the children may easily learn to distinguish them. The common rush, which they will find, by-the-bye, more within their reach on the margin than the sedge or reed, is often thought to

The common rush. be a kind of grass. But, unlike the grass, its stem is not hollow, but is filled with a soft pith running all through its length, and its leaves are mere sheaths around the base of the stem. The stem is rounded, and pointed at the tip, and of a bright vivid green colour. The exquisite flowers grow in a brownish cluster half-way up the stem (fig. 52, p. 286). The children will have read of rushlights—and will see that the soft pith forms a kind of natural wick. They will be able to make baskets of rushes, and thus repeat a very ancient industry among primitive peoples. The "bulrush," by the way, the tall plant with a rich brown cylindrical head, so often sold for decorative purposes, is not a rush, but a relation of the sedges. The sedges themselves may be known by their solid

triangular stems. They are much more like grasses than are the rushes, for they bear flowers at the top in spikelets, and they have long leaves, the lower half of which clasp the stems, though the little ligule which we find in grasses is absent.



FIG. 50.—SEDE

Reeds, on the other hand, are true grasses—tall grasses with jointed rootstocks and round, hollow stems, bearing stiff leaves. In August we see the reeds standing in the water crowned with a large, soft head of purplish blossoms, like those of a grass. If they can be reached, cut down a few reeds for the children and show them how our ancestors were able to make musical instruments from the hollow stems. The "reed" in myth and literature will henceforth have a real significance for them.

Plants on the surface.—Apart from the masses of green algæ, which form a close scum, the most common type of surface water-plant is the *duckweed*, which covers stagnant water with a green mantle. Procure some of this for the children and let them notice the little green, floating discs from which long threads hang down into the water. The teacher will know that these discs are not leaves, but more properly fronds, producing, besides the roots, very simple flowers. For the children it will be sufficient to point out how the green part comes up to the surface to manufacture food from the air, while the trailing roots absorb nourishment from the water (*vide* fig. 53, p. 289).

If we compare a simple plant like this with the water-lily, we find that the latter bears its broad, circular



FIG. 54.—FLOWER-HEAD OF COMMON REED

leaves and its beautiful yellow or white blossoms on long stalks, which are attached to a rootstock embedded six or eight feet below in the mud and debris at the bottom of the pond, where richer nourishment is to be found than the duckweed could obtain from the water above.

Plants below the surface.—If they look down into the water they will see floating masses of ribbon-like streamers (pond-weeds, *vallisneria* (fig. 53, p. 289), *elodea*, *anacharis*, *potamogeton*, &c.), which do not rise to the surface; and at the very bottom of the pond there are other plants, such as the curly pond-weed, which make a kind of sub-aqueous meadow. Specimens of these submerged plants can easily be obtained from a naturalist.

Kerner, in his "Natural History of Plants," throws light on the behaviour of these water-plants by explaining that green cells and tissues can function as far

down as the *light* can penetrate, but it is mostly the lowlier kinds of plants which live in this submerged condition in a subdued light. But some plants, of which the water-lily is one, can root themselves at the bottom of lakes, and by means of long unbranched stems lift up their leaves and blossoms to the light at the top. These plants do not need to use material to make woody tissue for their stalks, as is the case with land plants of a similar height; hence they can make large plate-like leaves. They



FIG. 52.
COMMON RUSH,
SHOWING
FLOWER

would be ludicrously "top-heavy" on land, but the water around them supports them and buoys up their leaves on the surface, where they can enjoy full sunlight. "In many cases, of course," continues Kerner, "the stem of the water-plants remains so short that it scarcely rises above the mud at the bottom of the pond, but the leaves arising from it are shaped into long ribbons whose freely floating ends ascend into the better illuminated upper layers of water" (*Vide* fig. 53, p. 289).

This is the explanation of the floating masses of ribbon-like vegetation, with branched habit and collapsible stem, that we see under the water in seaside rock-pools and in inland ponds. They are doing the best that their structure will admit of to enable them to reach the light.

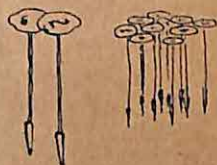
The water crowfoot.—The water crowfoot, a member of the buttercup order, whose beautiful white blossoms children will see in snowy sheets on ponds or slowly moving water in May and June, combines both these contrivances. It has broad three-lobed leaves floating on the surface of the water which manufacture food in the sunlight, and below the surface it has another set of leaves, quite different in appearance from the upper ones. The broad upper leaves would, of course, hang in a limp mass and be swept away by the current if they were submerged, but the lower leaves are split up into very fine streamers, almost like threads, which sway with every movement of the water and take up as much dissolved oxygen as possible, and do their best with it in the diffused light which reaches them (fig. 53, p. 289). Finally, the teacher must take what opportunity he can of getting the children to notice that some plants, like the water-cress, prefer gently running waters, while the duckweed would be swept away in any but quite still water.

Plants of the Bog.—We have left ourselves no space to

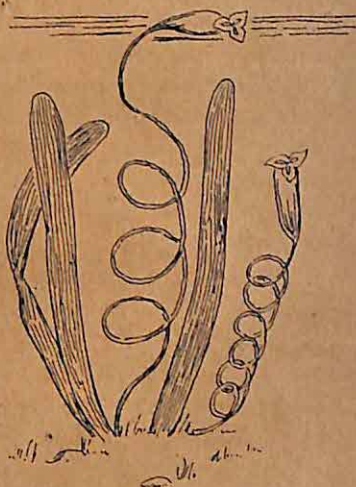
discuss the plants of the marsh or bog. But the white waving tufts of cotton-grass would always attract the eye of a passer-by and warn of unsafe treading. And in lessons on insectivorous plants mention is always made of the little sundew, the red gleam of whose leaves may be seen in boggy places. This plant, being unable to extract enough food from the watery soil in which it finds itself, converts its leaves into tentacles with sticky globes at their tips, which close over a flying insect and detain them while the plant absorbs their juices.



Water crowfoot; narrow threadlike
leaves below, broad leaves above the surface



Duckweed, broad
floating leaves.



Vallisneria, showing long
narrow submerged leaves.

FIG. 53.—WATER PLANTS

CHAPTER XL

BY PONDS AND STREAMS.—(2) BIRDS OF THE
WATERSIDE

Swimming birds.—The child's first instance of the adjustment of creatures to a water life is probably the duck. Nearly every manual of "notes of lessons" for young children contains a lesson on a duck, which brings out the adaptations seen in the webbed feet

The duck. placed far back to serve as oars for propelling the boat-shaped body through the water; the plumage protected by glands at the base of the feathers which secrete an oily substance, so that the "water falling from a duck's back" is proverbial; the broad, flat, spoon-like beak with the fringe-like arrangement on each side so that water and mud can be strained out, and worms, water-insects, crustaceans, &c., retained.

The duck usually seen is the tame (Aylesbury) duck, but the handsomer wild duck is kept in park waters and is almost domesticated, so much so that its original characteristic plumage has become toned down. The mallard, or drake, is very gay in colour from October to May, in his purplish-green, white, and chestnut-brown feathers, his bright cap of metallic green, his white collar above his chocolate breast. In the summer, however, when both birds are moulting, he resembles his mate, who is of a dun colour, but whose wings, like his, are marked with white and peacock blue.

The swan adds to the equipment of the duck a long curving neck, which enables him to seek food at a greater depth below the water. Town teachers can watch for the appearance of the grey cygnets on the ponds of a public park, and take the children to see them, when they will realise how it was that the young swan of Hans Andersen's charming story was taken for an ugly duckling. Tell them of the wild swans who come to the northern parts of our country in the winter from countries still farther north, and thus prepare them for understanding something of the part played by swan stories in northern literature.

The town teacher, too, can often introduce his pupils to another water-bird—the moor-hen, or water-hen. Though shy, it will live happily in roadside ponds or in the lakes of a park. It builds its nest among the waterside plants of a little island, or among the reeds at the margin where there is least chance of disturbance, and it is said sometimes to make a sham nest in a more exposed position, while its real nursery is well under cover.

The water-hen is smaller than a duck, blackish in colour, with white feathers under its tail, which are continually fluffed as it swims, and a handsome red cap on its forehead, as well as a red bill. It is a dainty little creature as it swims about with the flirting movement of its white feathers and a nodding motion of its head. Sometimes it may be seen searching for insects among the grass of the waterside, where its size and gait remind one of a bantam fowl. It has long toes, which help to support its weight and carry it lightly over floating vegetation, and with these it can cling on to waterweeds when it has dived below the surface for safety. The children may perhaps see the little fluffy

black "chicks" with their reddish caps. The moor-hen brings up three broods a year, and the elder ones of the first brood help the younger ones to find food as they swim about. But in the autumn the wild moor-hens drive off their families to seek fresh waters, and in the night they take their flight across country to find some distant pond or marsh where they may make new homes of their own.

Wading birds.—The elder children will be interested in noting that, as in the case of plants, there are various degrees of adaptation to a watery life. The swan and water-hen are swimming birds; they move best upon the surface of the water, and on or below the surface they find their food. The wading birds, however, must find their food just within the margin of the water. The

The heron. heron, often seen with clipped wings by the ornamental waters of a park, is a wading bird. The stork of Hans Andersen's fairy stories, almost more of a familiar image in a child's mind than the native heron, belongs to another group of wading birds. Let the children notice the heron's long bare legs, the strong, unwebbed, spreading toes, the S-shaped neck, and the sharp-pointed beak with a very wide gape. The creature is perfectly adapted to stand knee-deep in the shallower parts of a stream or lake, its strong toes giving it a firm foothold below, and its stilt-like legs lifting the feathered part of its body well above the water. Then, when it sees a fish or frog, it will suddenly stoop, curve over its long neck, plunge its sharp beak into the water, bring it up again with the prey gripped between the upper and lower mandibles, hold the beak almost upright, and gulp down the victim.

If the children are not near a heronry, show them a picture of herons flying, in a slow majestic train, their long legs stretched out straight behind and their great

wings outspread into a kind of blunted arch. The heron is our largest English bird, and it has been remarked that the fact that we have so few large birds whose flight may be watched—for the birds of passage that cross our island generally pass overhead by night—makes our skies seem empty as compared with those of India, for example. The children will like to know that the heron, though it haunts the waterside, builds its nest of sticks in a tree, and prefers to build in companies, as the rooks do. Show, for comparison, a picture of a stork's nest on a housetop or haystack.

Waterside birds.—The heron is a fishing bird. The kingfisher, as his name tells, is also a fisher, but his methods are not the same. The sight of a kingfisher is a red-letter day in the life of a young naturalist, and all children should see a picture of the bird or a museum specimen in order that they may be able to recognise the glorious flash of blue along the stream, which means that the bird is hawking, as it were, up and down the water looking for the fish which forms its food. More usually, however, it perches on a twig just above the water until it sees something moving below, when it darts down and seizes the prey with its great beak. Let the children notice how large is this beak in proportion to the size of the body, and how the tiny feet evidently mark out the bird for perching while it waits; it could never wade like the heron. At South Kensington the children will see the long burrow in the bank where the bird makes its untidy nest of fish bones, and it may be pointed out to them that the mother kingfisher, since she is in no danger of being seen by enemies while bringing up her family, may indulge in plumage as bright as that of her mate.

There are some birds which, though they do not swim or wade in the water, or hover over it, yet like

to live near it. Of these the most familiar to the country child, and the one which can be most easily

The water-wagtail. recognised by the town child on his first visit to the country, is the water-wagtail, or pied wagtail, as it is called. It is easily

known by its black and white plumage and by its long up-tilted tail, which is in a perpetual up-and-down motion; hence its name—wagtail. A pair of them will almost certainly be seen near the edge of any ditch, pond, or small stream, and the children will notice that they *run* instead of hopping as most birds do. They run along by the waterside picking up insects, or now and then flying to catch one in the air. The sharply-pointed wings and the white and black barred body and tail give the bird a very neat appearance. Perhaps this trimness and the quick to-and-fro movement of the tail procured the bird its homely name of Peggy or Polly Dishwasher.

Another waterside bird is the sedge-warbler—a little brown bird somewhat smaller than the sparrow, with

The sedge-warbler. reddish-brown feathers streaked with a darker brown on its back, a light buff

colour below, and a white line like an eyebrow over the eye. The sedge-warbler is a very garrulous bird, and not at all shy. It lives in bushes, preferably by the waterside, though it will sometimes seek other haunts, and its song, loud, chattering, and incessant, may be heard by day and night during the time it is in England—from April to September. A pebble thrown into the bush, so far from frightening it, will cause it to break out afresh into song. The sedge-warbler may be heard in the London parks.

The reed-warbler. Its relative, the reed-warbler, is less common. It hangs its nest—a cup-shaped nest of dry grasses—between three or four

reeds, hence its name, though, like the sedge-warbler, it will be quite contented away from water.

CHAPTER XLI

BY PONDS AND STREAMS.—(3) ANIMAL LIFE

Beasts of the waterside. — The beasts of the waterside—for the otter has been almost entirely exter-

Water-rat. minated—are quite small and inconspicuous. The water-rat or water-vole, however, is often seen swimming through the water or diving from the bank. It is like a house-rat, but has not so long a tail, and is stout rather than slender in its body. It has short, roundish ears which are unlike the somewhat perked-up ears of the house-rat, and are concealed among the fur on its blackish face. The home of the water-rat is in a burrow among the grass and roots on the bank, and there it finds some of its food, but it also eats the softer parts of the stems of flags and mare's-tails, which grow just within the margin, and is very fond, too, of duckweed. Though it can freely dive and swim, it does not care to be long in the water, and soon makes for a place of refuge. Calverley's delicately humorous little poem, "Shelter," will give the children a pleasant word-picture of the ways of this little creature which will sharpen their eyes when they come across it.

A tiny, bluish-black animal, the water shrew-mouse, **Water shrew-mouse.** is another water-haunting creature, swimming through it as a dog does, and diving in search of food. Its long, snout-like nose differentiates the shrew from the mouse. Whereas the water-rat is a rodent and a vegetarian, the shrew-

mouse is an insect-eating animal, like the hedgehog and the mole. Besides insects, it will eat very small water creatures, tiny fish like the minnows or fresh-water shrimps, for example.

The animal world in freshwater ponds and streams.
The birds and beasts of the waterside are readily observed in the country, and the local museum helps to identify them. Dr. Scott, in his "Nature Study and the Child," points out that plants and animals may be regarded in three ways.

1. Organisms in close relation to earth, soil, water, air, sun, to other plants and animals, and to man.
2. Structures fitted or adapted to their environment.

3. Types of other plants and animals, some of which the children see, many of which they only read about.

The town teacher must perforce often regard his material more from the third point of view, especially with reference to the shyer and less familiar creatures, and to those that inhabit another element. But if he has to fall back upon the museum or the local zoological collection for many types, he may nevertheless do much more at the expense of a little trouble. The batrachians of the ponds and streams—the frogs and newts—may, as we have pointed out, be studied at first-hand by the help of a simple school vivarium. The life of a fish, too, can be studied with goldfish in a glass bowl or in a little tank.

Small fish.—Specimens from the native ponds or streams, however, will always be forthcoming where there are boys who have access to them, and the teacher in country or suburb will be embarrassed by the offer of minnows or broad-headed "Miller's thumbs" or "Jack-sharps" (sticklebacks) in pickle jars, the result of a half-holiday's "fishing."

Neither of these creatures, to say the truth, is easy to keep in an aquarium. Here is an instance in which the creature depends very much for its comfort and for life itself on the natural conditions of its habitat. The stickleback is an embarrassment, at any rate with young children, because he is so exceedingly voracious and combative. He will not only kill other creatures, but, unless he has plenty of space and food—worms, caterpillars or such small fry—those of his own kind also. The common stickleback (with three spines) is very easily caught in ponds or streams. The three spines on his back, and his spiny ventral fins, show how well equipped he is for offence as well as defence. He will rear them up if a stick is placed in the water near him, and actually attack the stick with them. The story of "Father Stickleback" is always interesting to little children, and it does sometimes happen that a teacher who takes trouble can illustrate his narrative by showing a family and nest in the special tank set apart for sticklebacks. This should contain plenty of weed, and be of ample size. Not more than two pairs should be accommodated together, and then each pair will keep to its own special domain. At the breeding season, spring and early summer, "Father Stickleback" is very beautiful to behold. Besides his spines, which are not yet torn by fighting, he has bright, bronze-green plating on his back, and clear scarlet on side and throat. It is always fascinating for the little ones to hear how he builds a nest at the bottom of the water, weaving it of the fibres and roots of water-plants; how, when the eggs are laid, it is he, and not the mother, who guards them devotedly, rushing at any intruder who comes within a little distance of the nest; and how, even when the eggs are hatched, he watches over the little ones, not allowing them to

wander too far for fear of danger. The muff-shaped nest, open at both ends and slung like a bird's nest on the boughs or the stems of water-plants, is often shown in illustrations in connection with the common (three-spined) stickleback. It is made, however, by the nine-spined stickleback, which is black, and not bright-coloured, before the eggs are laid.

The minnows are pretty little creatures, but as they like running water their owners should be induced to show them, and then return them to the stream. They should not be put into the school aquarium unless an inflow and a waste pipe have been arranged.

Minnows. The invertebrate creatures of the pond or stream.—The creatures we have noticed are all vertebrates, and are fairly familiar. Their presence in or around the water is taken as a matter of course, which according to the teacher's skill and opportunity may also become a matter of interest. A more difficult task, and one that cannot be successfully attempted until the children have had some experience, is to lead them to realise that an ordinary pond or stream is a world in itself, a complex natural community, a compendium of animal life in a small space. All the creatures that they have seen on land are represented by other creatures constructed, as it were, on the same pattern, but with adaptations which enable them to lead a watery life, in fresh or salt water as the case may be. These conceptions come with more force after a visit to the seaside, when the children have had some experience of the marvels of animal life just off the edge, as it were, of terrestrial conditions, and some glimpses of the abounding life in the great waters beyond.

To take the crustaceans. Children in Derbyshire, or near the Downs, may learn that the crabs or lobsters have a relative—the fresh-water crayfish. This is

found only in streams running through chalk or limestone regions; here it can find material for the "shell"

Crustaceans.

with which, as is the case with all crustaceans, its jointed body is covered. The fresh-water shrimp, a humbler crustacean, may be caught by dozens in any pond. Its body is very much curved over, and its legs are very much spread out, for it sometimes needs to walk on weeds or mud, as well as to swim. The little grey "wood-louse," by-the-bye, which is so often found under damp stones or timber, is not a louse or an insect of any kind, but a crustacean which, though it likes moisture, prefers it in a less degree than the crayfish or the fresh-water shrimp find necessary.

As there are land-spiders, so, too, there are water-spiders. The children know that a spider's body shows

Water-spiders.

two distinct portions, joined by a very slender waist. The head and thorax together form the fore part, and the globular abdomen the hinder part of the body. The spider has no wings and has eight legs. The water-spider has the same general structure, but its abdomen is longer and more oval. Now, the spider, though it lives in the water, breathes atmospheric air. The crayfish breathes by little plume-like gills lying in a cavity between its body and limbs, and these gills are bathed by water which gives up oxygen to them. But the spider has no such provision, and it would seem, therefore, that it must constantly come to the surface. As a matter of fact, it does come to the surface from time to time, but besides this it manages to provide for itself a stock of air below the surface. It spins a kind of bag-like web which it fastens with the open end downwards to the stems of water-weeds. Then it goes up to the surface and brings down with it, between its hind legs, a bubble of air. Air is also entangled between the very fine close hairs which cover its body. This

coating of air gives it a silvery appearance. It climbs down by a thread which it spins for the purpose, and at the mouth of the web it passes the bubble upwards into the reservoir. This it does many times, until the web is bell-shaped, being full of air. Now, the water-spider can stay below for a considerable time, breathing the stored air. The bell is sometimes used as a nursery for the eggs, though often another cocoon-like shelter is provided for this purpose. The eggs hatch out at once into baby-spiders; there are no intermediate stages as in the case of insects, and the mother guards them very carefully. Living specimens of water-spiders can be seen by London children in the Stepney Borough and Horniman Museums.

CHAPTER XLII

BY PONDS AND STREAMS.—(4) ANIMAL LIFE

Water-insects.—The large class of insects is well represented in streams and ponds. This will probably be a new idea to children, who think of insects as creatures of the air, and who realise that a butterfly or bee, if immersed in water, will drown. Professor Miall's wonderfully interesting book, "Aquatic Insects," will help the teacher to realise some of the marvellous adjustments which have made it possible for insects to live in water. The author points out that insects as a class are so active, so hardy, so ingenious that they can easily change from one medium to another. Though most of them are, indeed, terrestrial, moving about on the surface of the earth to seek their food, yet even here they show all kinds of expedients: some have learnt to burrow in earth, in wood, or even in the tissues of leaves, while a large proportion have learned to fly. That they should manage to exist in water, and that, too, under all kinds of conditions, is not so surprising when we consider their versatility and cleverness on land.

Special arrangements are, of course, necessary to enable them either to breathe dissolved air below the surface of the water, or to obtain a supply of atmospheric air from above, and wings must be replaced by other organs of locomotion.

Insects aquatic as larvæ only.—It will be easy to point out to children that there are some insects

which live in the water only while in the larva stage, and after that take to a terrestrial life. Others remain in the water throughout their whole existence. The study of the tadpole and of the fish respectively will have prepared them for this conception.

Children ought to know that an open ditch or a stagnant pond, or even an uncovered water-butt, is sure to produce clouds of gnats. The gnat is a relation

Gnats. of the mosquito, for whom, by-the-bye, it is often mistaken, and in the hot weather its sting can be almost equally troublesome. The eggs of the gnat are laid on the surface of the water, where they float together in a little raft. When the larva is hatched, it floats head downward at the surface of the water, finding its food in minute particles just below the surface. When it is about to become a perfect insect, its pupa-case forms a little boat in which it can be safe while its limp legs and wings are being drawn out of their wrappings and dried. Then it soars up into the air, and does not come back to live in the water again. Tell the children how the mosquitoes in swampy districts bring not only pain but germs of disease to the inhabitants, and how certain diseases can be entirely prevented by draining the swamps where the creatures breed or otherwise destroying the mosquitoes.

The dragon-fly is the insect in which the children will take most delight, both for its beauty and for the strangeness of the transformation it undergoes "from a sluggish larva lurking in pools to a glorious winged creature flying swiftly through the air."

Dragon-flies. Tell them the story of its life—how the mother lays her eggs in the water, at or near the bottom of a stagnant pond. When the larva is hatched it is most voracious. It does not hunt its prey, but clings to the stem of some water-weed at the bottom of the pond, motionless until something good to

eat—an insect, a snail, a tadpole, or even a small fish—comes near it. Then it thrusts out a pair of very curious jaws, and seizes its victim. It has an enormous pair of eyes, and a part of the head is brought forward over the jaws like a mask, so that it presents a most terrific appearance.

It does not pass into a resting stage in the same way as the caterpillar of the butterfly, for instance, but changes more gradually into the perfect form. When the time comes near for the completion of the change, it climbs up the stem of some plant which grows partly in and partly out of the water, and when it gets above the surface rests there for a little while; then it gradually works itself out of its last coat, which is left behind—a complete model of the insect itself. But it does not yet fly away, for its body is very soft, its skin moist and tender, and its wings small, flabby, and crumpled; it could not fly in this condition, so it must remain helpless for a time. But in an hour or so the skin dries in the sun, the wings are spread out and dry also, and then the creature takes flight. It is very beautiful, with its long slender body, rich with such exquisitely pure colours of blue or red, its broad yet delicate nerved wings, its large gleaming eyes. Tennyson has described the scene—which, by-the-by, generally occurs in the early morning—with a faithfulness of detail characteristic of him:

To-day I saw the dragon-fly
Come from the wells where he did lie.
Some hidden impulse rent the veil
Of his old husk; from head to tail
Shone out clear plates of sapphire mail.
He dried his wings; like gauze they grew,
Through crofts and pastures wet with dew,
A living flash of light, he flew.

Professor Miall more dispassionately points out

that in the habits and life history of the dragon-fly we find the most emphatic contrasts. There is the contrast between the sordid life in a muddy pool and the animated life of a creature strong in flight. Moreover, the graceful form and lovely colours of the winged insect are combined with fiercely carnivorous tastes," for the dragon-fly lives by devouring insects, which it catches on the wing. It is the "swallow among insects," and flies and darts and wheels even more swiftly than the swallow itself (fig. 54, p. 307).

At almost any time of the year the children will be delighted to find the little cases made by the larvæ

**Caddis
worms.**

of certain water-insects—the caddis flies—caddis worms, as they are generally called.

These little larvæ collect bits of leaves, sticks, grains of sand or gravel, roots, fragments of the shells of water-snails, anything they can find, and make for themselves a tube-like sheath in which they take shelter. With this protection they creep along the bottom of the water and up and down the weeds, thrusting the head and forepart of the body out of the sheath, and dragging themselves along by their six legs. The perfect insect emerges as a four-winged fly, and then the empty cases are left. They can be picked up by the margin of any pond at the end of the summer. But live caddis worms can easily be kept in an aquarium, care being taken, of course, that they have plenty of material wherewith to make their cases (fig. 54, p. 307).

Insects spending their whole lives in water.—Among the insects who spend *all* their lives in the water are many kinds of beetles. The shining dark

**Water-
beetles.**

bronze specks about $\frac{1}{4}$ -inch long that agitate the top of the water so swiftly are the "whirligig" beetles. The "lord of water insects" is a big beetle, the great water-beetle, whose glittering wing-cases form a suit of polished armour which is

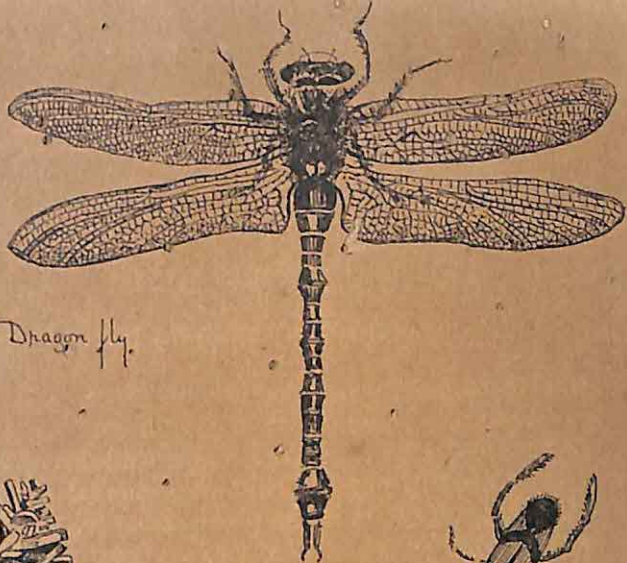
bordered round its edge with a band of yellow ; hence its name—*Dytiscus marginalis*. Beneath the wing-cases are the true wings, which, however, are only used occasionally in moving from one pond to another. As it is $1\frac{1}{4}$ -inch long, it is easily observed ; but if kept in an aquarium it must not be put with other creatures, as it is exceedingly voracious and will soon demolish them ; it must be fed on worms or dead fish (fig. 54, p. 307). The black water-beetle is larger still, but not so common, except in the southern counties. It is a vegetarian.

There are curious little insects whose legs are adapted for actually skating on the surface of the water, or rather on the invisible film of air which coats it. The elder children, too, will like to see the water-boatman, an insect half an inch long, whose hind legs are modified into beautifully feathered oars, with which he rows himself, back downward, in the water (fig. 54, p. 307).

Water-skaters and water-boatmen. **Molluscs.**—Freshwater mussels, cockles, and limpets are found in ponds and streams, but among the molluscs pond-snails are most often kept in school aquaria. The black water-snail, *Planorbis*, with its flat coiled shell, and the long trumpet-shaped *Limnæa* are the most common. They like to float head downward just at the surface, but they can also breathe below it ; their method of feeding can easily be watched through the glass. The long strap-shaped tongue of *Limnæa* scrapes away the green growth of algæ on the side of the jar, and they often cleanse one another's shells in the same manner (fig. 54, p. 307).

The study of the worms, leeches, and other still lower forms may be reserved until the young naturalists can use a microscope ; in the meantime the simple school aquaria will give them an idea of the abundance and variety of the life that awaits their study even in a tiny pond. The

aquaria, as we have said, need not be elaborate, and the apparatus required for the study of pond-life is not complicated. A little net is wanted for catching minnows and beetles and other floating or swimming creatures. This may be made of muslin slung on a wire ring which is fastened to a stick. A long stick with a hook at the end will be needed for water-plants growing out of reach. A net fastened to a weighted wooden frame can be used as a dredge to secure specimens of weed, larvæ, &c., from the mud at the bottom of the water, and plenty of jars must be provided both for dipping and for carrying home the creatures *separately*; for it is cruel to place them all in a confined space where most probably they will slaughter one another. These jars may also be used as aquaria. Green slime settled on the side may be removed with a toothbrush or a rag tied on a stick. London teachers desirous of starting fresh-water aquaria cannot do better than visit the Whitechapel, Stepney, or Horniman Museums, where the curators are most willing to give help and advice.



Dragon fly.



Caddis worm case.



Water Boatman



Great water beetle
Dytiscus Marginalis.



Freshwater snails.

CHAPTER XLIII

FRUIT GATHERING (1)

ALL through the summer the children will be able to study the commonest fruits, if not in garden or orchard, at any rate from shops and barrows. They will be able to gain at least two general notions from this study: first, that the plant stores its most precious product, the seed, in a great variety of ways; and, second, that Nature evidently spreads her table not for man alone, but for countless others of her children. We must lead our pupils to see that the "Uses" of a plant are by no means so few as those indicated in the object-lesson books of an earlier date.

The homely pea-pod is perhaps one of the simplest forms of a fruit-case. The children may easily see that it is a folded leaf, with the seeds attached in two rows by little stalks to the seam or "suture" formed by the edges of the leaf meeting opposite the mid-rib. The little stalks are of great importance in the early stages, for by these nourishment is conveyed from the parent to the ripening ovules. Let the class make models of a leaf in paper, fold it over, and fasten little pellets of clay to represent the seeds. Have one or two examples of pea-pods which have been left to ripen on the plants, and let them see how the sides of the pod shrivel, and how at last the peas drop out. The observation of the *storage* of seeds is a necessary preliminary to the study of the *scattering* of seeds,

**Types of
common
fruits.**
**The pea-
pod.**

to which we shall devote a following chapter. Nature conserves and hoards only that she may distribute.

In "shelling" peas, children will often find little maggots or grubs. These are the larvæ of a weevil, a variety of beetle which lays her eggs in a snug place where the young will find plenty of food when they are hatched.

Berries.—Currants and gooseberries stow their seeds in globes of juicy pulp, into which the little hard seed-box expands when the blossom has fallen. The remains of the calyx can be seen at the crown of the berry. Let the children compare the fruits of cucumber and vegetable marrow and notice that in these cases also the seeds are buried in pulp which, however, is far less juicy than the pulp of a gooseberry. These fruits are really gigantic berries. The banana sold in England is a berry that has lost its seeds.

The sweet, succulent berries of the currant and gooseberry form, as every gardener knows, a banquet for birds. A blackbird or thrush will strip a currant bush in the neatest fashion. The gardener may save the bushes from the attacks of the caterpillars, gooseberry sawfly, and the magpie (currant) moth, who feed upon the leaves and thereby reduce the food-making powers of the plant, only to find that the ripe fruit is devoured by the bolder garden-haunting birds. Yet this is evidently what Nature intended in giving the berries their sweetness and their attractive colour.

The strawberry not a berry.—A strawberry is not a berry at all. The top of the flower-stalk (receptacle) has formed a swollen cushion of red, delicious pulp from which stand up, like pins from a pin-cushion, the tiny little yellow fruits or nutlets (achenes). Each of these contains a seed. The lowly habit of the strawberry, which sends its stems running along the ground

to strike down a new set of roots at a distance from the parent, exposes it to attacks not only from the sharp beaks of birds, but also from the rasping tongues of snails and slugs.

Drupe. The cherry, &c.—The cherry harvest comes in July and August. Let the children, if possible, see the whole tree and trace the whole history of the fruit. The older ones may note the distinctively brown shade of the bark and may see with the naked eye the lenticels, or breathing spaces, which it shows. Let them note and draw the long, shining leaves, finely serrated at the edge. Let them, as Ruskin recommends, study the whole biography of the fruit, beginning with the pure white blossoms of the spring (note that compared with those of the apple these are almost colourless). Then comes the hard, green, seed-case, which finally ripens into the plump, juicy, richly-coloured cherry. Here we have a new type of fruit, the drupe. Compare also plums, damsons, apricots, peaches, &c. The inner wall of the seed-case which was above the insertion of the other whorls of the flower (superior ovary) has become hard and stony, while the outer wall has become fleshy, as in the berry. Though these fruits protect themselves with a fairly hard rind, and sometimes, as is well seen in the plum, with a coating of wax or bloom, yet insects manage to pierce them, and not only birds, but wasps and flies, will make many a meal from them. The plant, however, desires to attract birds, and to this end produces a sweet pulp with a specially attractive colour. Birds carry away the heavier stone fruits, and by dropping the undigested stone at a distance give the contained seed a chance to germinate away from the shadow cast by the parent. Children often paint and draw cherries without noticing how the long stalks correspond with the long flower-stalks of which

they should possess an earlier record in their notebooks. They should also notice the difference between the growth of the cherry and that of the apple. The apple, a heavier fruit, keeps much closer to the stem.

Collection of drupes.—The raspberry and the blackberry are collections of small drupes. The children can see, as well as feel with their teeth, how each little globe of juicy pulp has its own tiny hard "stone" within. These are not borne on a cushion, like the little fruits of the strawberry, but are separately enveloped, each in its containing "drupe," which was one of the many carpels seen in the flower. The top of the flower-stalk is well seen in the raspberry, and less well in the blackberry; but in each case it stands up like a finger, over which fits a thimble—the group of succulent fruit-vessels.

Apples and apple-trees.—The apple harvest is a beautiful sight in the South-West of England, or among the orchards of Kent, but in the autumn even the town child may have the luxury of seeing and eating English apples. It is worth while letting the children distinguish the various kinds of apples, as russets, pippins, golden knobs, &c.; and here it may be remarked that the craving for apples corresponds to a real physical need, and apples should form a frequent article of diet.

A full-grown apple-tree should be recognisable at any period of the year, and the children should be able to distinguish it from a pear-tree. The apple-tree has low, spreading, often gnarled and crooked branches. Apple-trees which are to bear well cannot be left to Nature. The fruit, it will be noticed, is borne on short spurs. Shoots which will bear wood and leaf-buds only are pruned away in order to direct the nourishing sap to the fruit-bearing branches. A demonstration of the process

of grafting will interest elder children, and in the country a sharp look-out should be kept for the mistletoe, the pretty parasite which is not uncommonly found grafting itself naturally on apple-trees, and nourishing itself at the expense of its "host."

The juicy part of the apple-fruit is thought to be formed by the growth of the receptacle which, with the lower part of the calyx leaves, swells up round the true seed-case, the core. It bears

Formation of the fruit. the remains of sepals above it. The core is a tough, five-chambered sheath, each chamber containing two seeds. Even little children, if shown a transverse section, can appreciate the neatness of this arrangement. As in the case of the cherry, the whole story of the growth of the apple should be recorded by means of brush and paint, and it will be useful to compare it at the same time with the pear.

Whereas, as we have noticed, the apple-tree is short and gnarled, the pear-tree is tall and pyramidal. Young apple-leaves are white and woolly on the underside, but this is

Apples and pears. not the case with those of the pear. Apple-blossoms have petals which are white on the inner side, but there is a beautiful rosy tinge on the outside where the edge turns over to make the cup of the corolla. The anthers are yellow. The petals of the pear-blossoms are white, like those of the cherry, but a tinge of colour is supplied by the red and purple anthers.

Spoilt apples.—A child is often disappointed over a "spoilt" apple. In this way he learns that the apple is a dainty morsel not reserved for human consumers only. There is often no visible insect consumer, but nevertheless the fact that the apple, even more specifically than the curate's egg, is "excellent in parts" only, is due to the previous tenancy of one of the objects called vaguely "maggots." Tell the children the story

of this spoilt apple. When the apple was forming, when it was no more than a small green knob, the codlin moth, a little creature with grey wings flecked with brown and copper, laid an egg on the future fruit, near the "eye." Unfortunately she did not lay all her eggs on one apple, but flew from this apple to others, until a large number, perhaps fifty, were infected. From each egg came a little whitish larva, grub, caterpillar, or, as it is wrongly called, worm. Finding itself on the outside of the apple, it bored its way in. It continued boring until it came out on the other side. Then, it returned, found its way to the core, and began to consume the pips. Now, the juices of the plant that would have gone to nourish the all-important seeds were no longer required, for there was no work for them to do. Consequently the fruit ceased to grow, ripened before its time, and fell to the ground. "A windfall" is a proverbial expression for a lucky and unearned boon, but the "wind-fallen" apples, as a matter of fact, are nearly always those infested by the caterpillar of the codlin moth. The larva does not remain in the apple after it has fallen, but finds its way out—the black hole which marks its exit is easily seen—crawls away over the ground, and makes for the trunk, which it climbs. By this time it is ready for the pupa stage, and it spins a snug cocoon for itself in some chink or on some ledge in the bark. There it will stay during the winter, and in early summer emerge as a codlin moth, which will lay eggs and thus produce a new generation to prey upon the next year's apples.

Precautions in the orchard.—The behaviour of this moth and of other destructive insects explains what children will be sure to notice in our orchards—the unsightly whitening of the tree trunks. This is done in order that the lime may destroy the larvæ and pupæ

of the insects that infest the tree. Other mixtures are used for spraying the tree so as to render it unpleasant to the moths. People whose business it is to produce apples do this on a large scale directly the flowers have fallen. Sometimes we notice collars or bands of sacking, tow, or flannel tied round the trunk of apple-trees; these are traps for the caterpillars which crawl under them for shelter, and orchard-keepers are careful to gather up and burn all dead branches and twigs which, lying under the tree, might serve as winter quarters for the pupæ. It is a good thing, too, to let poultry run in orchards to keep down the insect life.

These are man's expedients. Nature, while she lets the smaller creatures prey upon it according to their kind, herself defends the apple-tree in a variety of ways. Scott Elliot, in his fascinating "Nature Studies," enumerates some of the enemies of this favourite tree.

**The
enemies of
the apple-
tree.**

Burrowing beetles like to prey upon the delicate layer of living and growing tissue just under the bark. The bark, therefore, is very corky. A small insect, resembling the green fly, sucks the juices of young and tender twigs; these we find protected with hairs. Leaves are devoured bodily by caterpillars of the winter and great winter moth. Apple-suckers and apple-weevils consume the buds, though the codlin moth, which attacks the fruit itself, is perhaps the worst offender. Birds, though they may take toll of fruit, are evidently man's allies against this horde of insect ravagers. The stronger-billed birds are needed at the roots, where we find the grubs of the daddy-long-legs, of the cockchafer, and the wireworm. Mice, rats, and voles also attack the roots. Before the apple-tree was cultivated it was also exposed to the attacks of cattle, rabbits, and hares, which tear or nibble off the bark or leaves. If an ordinary tree is looked at in this

way we may learn something of the impartiality of Nature, and judge something of the education man has undergone in taming her as through the long ages he has taken up the task imposed on our first parents, the tilling and dressing of the soil, and the fostering of the "kindly fruits of the earth."

CHAPTER XLIV

FRUIT GATHERING.—(2) ALONG A HEDGEROW

Hedgerow fruits.—Children do not realise that the fruits of the garden, abundant though they are, form only a tiny portion of the great feast spread forth on Nature's banqueting table for her myriad tribe of insect, bird, and beast. The observation of garden fruits should be supplemented, whenever possible, by a walk along a hedgerow in autumn.

Hips and haws are always conspicuous and attractive, and will be specially so if the children have noticed

The red fruits. continuously, and recorded with brush or pencil, the changes that have taken place throughout the summer since the appearance of the blossom. The "haw" is like an apple on a smaller scale; the top of the flower-stalk, carrying with it the remains of the calyx, has grown up round the true

The haw. seed-vessel within. The outer red covering attracts birds, and though it is not particularly palatable, they will devour the pulpy contents in hard weather. The device of colour for attracting birds, so noticeable in garden fruits, is equally well seen along the hedgerow. Red is a conspicuous colour, especially when relieved against the green of the foliage; moreover, as Scott Elliot points out, each red-fruited

The hip. plant has not only its special shade of red, but also its special shade of the green against which it is relieved. Thus the red of the hip, the fruit of the wild rose, is of a purer, intenser red than that of

the haw. The shape of the hip is very beautiful, and the children are quite capable of appreciating the grace of its urnlike form, as well as of the glossy scarlet colouring. The urn is formed, like the haw, of the up-growing receptacle, and the remains of the calyx often form an irregular garland round its rim. Let the children open the urn and find within the hairy nutlets attached to the sides and bottom of the vessel, with their brown tufts, the styles, filling the upper part of the urn. Each of these nutlets is a carpel containing a seed, but the adhesion of the seed to its containing carpel is so close that the children will not distinguish them.

Another red fruit of the hedgerow or woodside is that of the rowan, or mountain ash, as it is often wrongly called. The confusion arises because of
The rowan: its large compound leaves, which are at first sight like those of the ash. From five to nine large leaflets grow opposite to one another, with an odd one at the apex. The shape of the leaflets is almost oblong, only tapering at the tip, and the colour is of a bluish silvery green on the upper side, with very much paler green below. The leaflets of the ash are farther apart, and are more slender and pointed, while the colour is of a more decided green. The whole effect of the ash-leaf is much more light and graceful than that of the rowan. The leaves of the ash, as well as the single leaflets, are *opposite* to one another, while in the rowan they come first from one side of the stem and then from the other. The flowers of the ash that emerge from its black buds in spring are small and purplish in colour, while the blossoms of the rowan are white and conspicuous. And the long dangling keys of the ash into which the tiny pistillate flowers develop are wholly unlike the bright red blossoms of the rowan that

are hung out early in the autumn. The rowan, indeed, belongs to the same family as the rose, bramble, apple, and hawthorn—the great family of the *Rosaceæ*. It is called the *mountain* ash because its natural home is on hillsides, as in the Scottish highlands, where it is a great favourite, and where it formerly had a high reputation as a protection from evil spirits; but fortunately for town-dwellers it makes itself at home anywhere in suburban gardens, as well as in the more open country of the English shires.

The Viburnum, or wayfaring tree, has coarse leaves and beautiful bunches of pointed red and yellow berries.

In some districts a beautiful variation of red fruit is seen in the spindle-tree. The tree, which grows in the hedges, is hardly noticed in spring or summer, but in autumn the ripe waxen fruit, pale crimson in colour, splits open its four lobes and shows within a rich orange globe (the aril) which serves as an extra protection to the seeds. The beautiful effect of colour is heightened by the purplish bronze of the foliage leaves. The children must be warned that though there is no harm in experimenting with hips and haws, the fruit of the spindle-tree is poisonous.

A similar warning must be given in the case of the berries of the woody nightshade, a climbing plant which trails its weak stems over the hedge. The purple flowers, with bright yellow anthers, arranged not unlike those of the cyclamen, give place to bunches of berries which show beautiful variations of colour from pale green through lemon, gold, and orange, to crimson red, according to the degree of ripeness. This woody nightshade, by-the-bye, belongs to the same family as the potato, and nearly all the members of this family have poisonous properties.

Woody Nightshade



Deadly Nightshade.

FIG. 55

The "deadly" or black nightshade, which grows nearer the ground, and has purple, bell-shaped flowers, giving place to black berries, is even more poisonous (fig. 55).

The very soft, pulpy, scarlet berries of the *honey-suckle*, beautiful as they are, must be severely let alone,

as must also those of the black bryony, or *Tamus*, as it should more properly be called, to distinguish it from the white,

or true bryony. The black bryony always attracts attention from its habit of festooning the hedges with its trails of twisted stems, heart-shaped

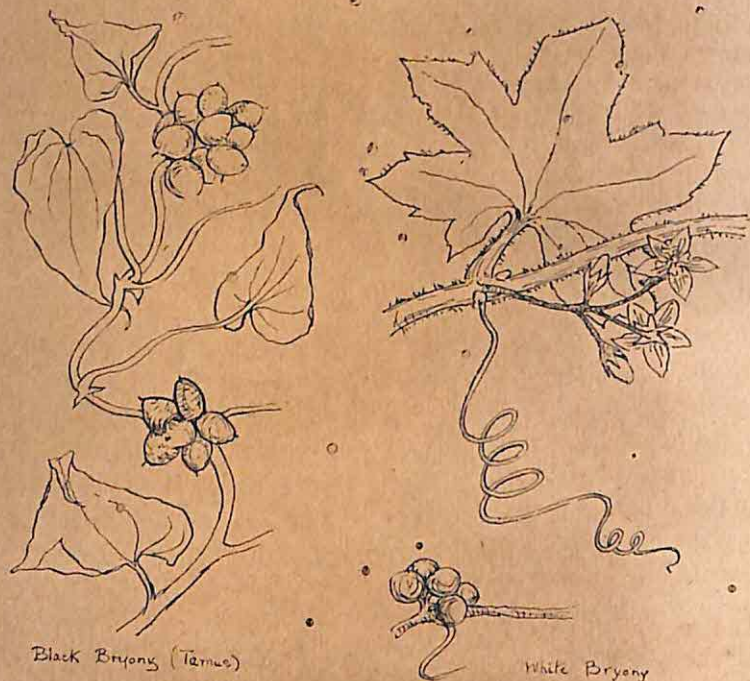


FIG. 56

leaves, and groups of berries varying in colour like those of the woody nightshade.

The true bryony, or white bryony, which belongs to quite another family (the cucumber family), twines by means of its tendrils, like the vine and the Virginian creeper. Its leaves and tendrils will remind the children of the cucumber and the vegetable marrows, which are its near relations, but its red berries must not on that account be eaten.

Let the children notice how the black bryony, like the honeysuckle, hop, and white convolvulus or bindweed, has climbed to the top of the hedge to lift up its blossoms and fruit, by aid of its twining stem, which curls in and out among stronger stems. All these, except the convolvulus, turn in a direction *following* that of the sun, the plant being supposed to be between the sun and the observer. The stems turn first east, then south, then west. The motion is in the same direction *as that of the hands of the clock*. The convolvulus, like the scarlet runner and French bean, twines in a direction *contrary* to the sun or to the hands of a clock. We noticed that the little cornfield plant, the climbing polygonum, which resembles the convolvulus and is often called by its name, climbed in a direction *following* the sun. The children, by-the-bye, should have specimens, say, of hop and convolvulus growing in their garden to observe these preferences of direction, and to make records of the actual spirals formed.

Touches of red are also given along the hedges by plants of lower growth. Among these, perhaps the most conspicuous is the fruit of the common arum—cuckoo-pint, lords-and-ladies, Jack-in-the-pulpit, as it is variously called. The whole plant is so interesting, and withal so common, that it should be noted throughout the year. In the spring its glossy, green, spotted leaves, shaped like enormous arrow-heads,

The black bryony a climbing stem. Comparisons.

The story of the common arum.

spring up quite early from the rootstocks below, which contain food-material stored throughout the winter. In April comes up the flower-stalk with the large, pale green bract (spathe), which is similar in shape to that of the arum-lily. This is the pulpit. Within it rises an erect, fleshy, purplish pillar, the flower-stalk or spadix, and near its base the spathe contracts to form a tube. The flowers themselves are arranged in three sets round the lower portion of the pillar. Nearest to the top of the column is a ring of bodies which represent stamens; these, however, produce no pollen. They are furnished with hairs, which bend downwards. Next comes a ring of perfect stamens, and below these a ring of pistils. Small flies come to the flower, either for shelter or attracted by the contrast of colour between the whitish bract and purple column, and also by the strong odour, as of carrion flesh, which it gives out. The down-pointing hairs allow them easily to reach the true stamens, which do not ripen, however, until after the pistils below them have withered. When the pistils are ripe, the stamens are not ready. Clearly the pollen of this particular flower is not designed for its own fertilisation. Fresh pollen is needed from other plants, and the flies which are caught below in the tube may have brought it just in time for the pistil as it reaches the proper stage. But they are detained by the palisade of hairs until after the pistils have withered and until after the stamens have opened. Then the pollen falls upon them, dusting them the more thoroughly as they search for a way of exit, until finally the fringe of hairs also withers, and the flies escape to carry their burden of pollen to some other cuckoo-pint whose pistils are in the right stage. The result of all this contrivance is that the ovaries at the base of the pillar ripen into a cluster of globular fruits, at first green and then scarlet. They are pressed closely together, and are

somewhat like tiny apples in shape. The bract and the upper part of the column wither, and the short stalk with its vivid berries catch the eye among the lower-growing plants of the hedge. Pheasants and other birds eat the fruit, but children must be warned on no account to touch it.



FIG. 57.—COMMON ARUM. Diagrammatic Section
h, hairs ; *a*, anthers ; *st*, stigmas.

The lore of the country-side, indeed, should include a knowledge of which fruits are respectively edible, harmless, and poisonous. Beside this practical knowledge, the children will thus extend the application of the proverb that "One man's meat is another man's poison" to the digestion of myriads of other creatures for whom, no less than for man, Nature has made provision. Some slight hint of the marvellous properties of herbs, even of poisonous ones—the knowledge of which has almost entirely passed from country dames and herbalists

to scientific students of medicine, may also be fitly given.

Purple fruits.—Purple darkening to black is another colour which prevails in succulent fruits. Purple sloes, the fruit of the *blackthorn*, and the juicy berries of the *elder*, of which we have already spoken, yield cordials to the thrifty housewife as well as food to the starlings and other birds.

The purple berries of the *dogwood* show up against the deep-stained crimson of its stem. The purple spikes of the *privet* berries, each berry nearly globular, stand up stiffly, as though conscious of their compactness, among the rather prim foliage which makes the *privet* so useful a plant for the hedges of a formal garden. These are gathered and consumed by the black-birds, thrushes, and other birds which remain with us during the winter.

Colourless fruits.—The children must not imagine, however, that juiciness and colour are necessary attractions in a bird's dietary. Remind them of the crowd of sparrows and other finches who descend upon the hay-fields and cornfields when the hard seeds are ripe ; other birds sharing their banquet. Show them, if possible, or at least tell them to watch for, the trim little goldfinches daintily pecking at the thistle-heads, at the tufts of dandelion and groundsel seed ; and the linnets busy among the seeding charlock. Were it not for these consumers the light tufted seeds of these plants would be blown far and wide, even more than now happens, and the farmer would have still heavier crops of weeds to deplore than at present.

**Their
consumers.**

CHAPTER XLV

FRUIT GATHERING.—(3) NUTS AND THEIR CONSUMERS

Pulpy Fruits.—The children will have seen that in succulent fruits Nature provides an attractive covering so that birds may take the seed away. But the pulp does not become coloured and juicy until the seed is ripe. While the little germ of the future plant is too young to germinate if planted, it is protected by a hard case, green to the eye, so as not to attract attention among the green leaves, and sour to the taste, so as not to invite experimenters to a second trial. When seed inside is ripe, the bird carries the fruit away, or the fruit falls to the ground and rots. In either case the "stone" within is left on the ground, trodden underfoot into the warm soil, and then, after a certain time, the living embryo in the "kernel" of a plum, for example, has sufficient energy to break through the hard shell and to form a new plant. Let the children plant a plum "stone," and see how long it takes to germinate.

Some fruits, edible for man or other creatures, are formed on a different plan as to the outward protection of the seed. An excursion for nut-gathering, or even the purchase of nuts, will help the children to note these diversities, and to

Dry woody fruits.

prepare them in a measure for the somewhat difficult niceties of the classification of fruits. By the time autumn has come the little crimson-tipped (pistillate) flowers of the hazel will have rounded into the nut,

while the little circle of bracts that surrounded it has lengthened out into a long, fringed hood or cupule,

The hazel nut. partly leafy and partly woody in texture, and first green and then brown in colour, so as to harmonise with the fruit which rests

within it. Let the children see specimens with the nuts still in position within the cupule, and note also how the whole structure, which in spring was almost seated on the branch, has been carried outward on a stalk. The true fruit is the nut, the cupule being only an accessory protection. The nut has a woody instead of a pulpy covering, for the kernel or seed, which contains the little embryo and its two seed-leaves. At the time when the shell and its protective cupule were soft and green, the little kernel within was a mere milky, unformed mass. (It is most important, as we have already said, that the successive stages of growth, and not merely the first and the last, should be noted.) But now the nut is ripe it has become large, smooth, and polished, and will soon slip from the containing cup and fall on the ground. There it may remain buried for a long time (nuts, as a rule, are slow in germinating), and then the seed within will burst through the woody shell.

Nut consumers.—But hedgerows and woods where hazels grow, or avenues and orchards where the cultivated "filbert" has been planted, have a population of their own, and some of these rely on nuts for their autumn food supply or for their winter larder. The children are familiar with some of the rodents of the house and field, at least with the house-mouse and the rabbit. The rodents of the field, hedgerow, and woodland include the voracious field-mice, who are great devourers of nuts and carry them off to their nests. The front chisel-teeth of the rodents or "gnawers," by means of which some of them destroy wainscoting

and wooden lutches, will enable the field-mice to attack not only the hard cupule but the woody "shell." And we have, moreover, arboreal rodents—the climbing, leaping, rodents of the trees—the dormice and the squirrels, whose favourite food is nuts. If the "shells" of the hazel-nuts were not extremely hard, these gnawing creatures would devour so many that there would be no chance of new nut-trees. The shells as they ripen become very woody and difficult to crack, so that a proportion of them escape these sharp incisors, and a fresh supply of nuts is assured in the future. Scott Elliot conjectures that the teeth of the squirrels have been growing sharper, and the shells of the nuts growing harder, so that the balance of spared nuts remains pretty much the same. These nut-eating rodents generally carry away their nuts to a safe place in order to consume them, or bury them in the ground, and occasionally forget them, and thus a good start is secured for new trees at a distance from the parents.

Nut-gathering or nut-buying gives a good opportunity for interesting the children in nut-consumers other than human. The dormouse is often kept as a pet, but since it sleeps most of its time it is not a very interesting creature as a companion. A little girl who tried the experiment plaintively reported that "it had no habits." Yet it is active enough at times. Though called the dormouse (sleep-mouse), it is in many ways more akin to the squirrel than to the mouse. It is a beautiful little animal, with very bright black eyes and rather a large head and furry tail, something like that of the squirrel. Its feet, like the squirrel's, are adapted for grasping and climbing; it is, says Douglas English, "the hedge-row gymnast and tumbler," frolicking there as the squirrel does on the high tree-tops; it sits up on its haunches, and eats nuts in the same fashion. Its

favourite nut is the hazel, but it is also fond of acorns and beech-mast. The dormouse is perhaps the most typical English *hibernating* animal. It sleeps for about six months in the year. Besides its summer nest, which is a nursery, it has a winter nest—a ball of fibre with no special opening, into which it can insert its body, and there it lies coiled up with its tail curled over its head and down its back. The nest is generally in a bush of furze or brambles, and honeysuckle stems form the favourite material for it. Before sleeping, the dormouse consumes a large quantity of food. The elder children may know from particulars of the diet of vegetarians that nuts form a highly concentrated food, rich in oil, and thus life is maintained while the creature is asleep.

The squirrel is much more engaging, but it is so lively and restless that it should not be kept as a pet except

The squirrel. perhaps, in very large cages or in enclosures (with tree-trunks in the space enclosed) such as are used in some public parks and in the Zoological Gardens. The little creatures kept there are charmingly tame, snatching nuts saucily from one's fingers and then running away to their stump to devour them. Some of these squirrels—the grey kind—have been let loose in the grounds and in Regent's Park, where they may be seen scampering about the grass, accepting nuts from visitors, stuffing one into each cheek as they run away to eat them, or burying them in holes, which they dig with their sharp little claws.

The American Indians call the squirrel "Shadow-tail," and the tail is a handsome relief to the little chestnut body with its white breast and to the sharp-pointed ears standing up from the restless head. So fluffy and loose is the fur of the tail that one sympathises with the teacher who, being reproved for talking about the "feathers" of the squirrel's tail, asked desperately, "Well, what would you call them?" Mr. Douglas

English himself speaks of the "feathered tail," and indeed the beastie uses it as the birds do theirs—as a kind of rudder to enable it to keep steady as it takes daring leaps from one tree-top to another. Let the children note how relatively strong and large are the hind limbs, and how well adapted for this mode of movement. The squirrel's hoard of buried nuts; how he forgets them now and then, how sometimes on a warm day in winter he wakes up from his winter sleep, descends from his warm shelter in the fork or hole of a tree-trunk, makes a meal, and falls to sleep again, are well-known facts of his life in which all children are interested. Even the quite little children will love the story of "Squirrel Nutkin."

But the rodents are not the only creatures who prey upon nuts; the birds have their share. The nuthatch is a clever nut-cracker. Whereas the squirrel strips off the green covering, and the dormouse patiently nibbles through husk, nut, and all, the nuthatch chooses a nut that has slipped from its cupule, fixes it in a convenient chink in a tree or wall, and hammers at it with its beak until the shell splits. The great tit imitates the nuthatch, but is not so dexterous at the work.

It would be strange if the insect tribes, so ingenious and so ubiquitous, made no inroads into nutland. Our hazel-nut is sometimes consumed, as we all know, by "maggots." The mother of these maggots, the nut-weevil, is a species of beetle provided with a snout for burrowing. In the spring she pierces the unripe nut and lays an egg within. In ten days it hatches out into a yellowish-white maggot with a horny, reddish-brown head and strong, jet-black jaws. When it has devoured the kernel it gnaws through the shell and escapes. Two poets have been kind to this maggot. Southey, who could write

delightfully to and for children—"The Three Bears" is his best-known contribution to nursery literature—pleads for it thus :

Nay, gather not that filbert, Nicholas,
There is a maggot there—it is his house—
His castle. Oh, commit not burglary !
Strip him not naked, 'tis his clothes, his shell,
His bones, the very armour of his life ;
And thou shalt do no murder, Nicholas.

He goes on to enumerate the dangers which the maggot may encounter—the nibbling teeth of the mouse, the hammering beak of the nuthatch, the sharp cracking of the squirrel's chisel-teeth, and so on. Shakespeare calls the maggot

The old grub,
Time out of mind the faeries' coachmaker.

The loose, bitter dust left in the empty shell may be easily shaken out, and there is the fairy coach ready to be fitted with "its waggon spokes of long spinner's legs" ("Romeo and Juliet").

The children will readily find other examples of nuts for comparison with the hazel. The acorn has a cupule with a clean-cut edge and roughened outside. **Acorns and pigs.** Pigs are very fond of acorns, as of "windfallen" apples. In the old days, before we fell into the way of condemning pigs to a confinement in styes and then abusing them for habits which our own treatment has induced, herds of swine were driven about the forests, and a wood was spoken of as giving food "for so many pigs." The wild creatures of our modern woods who eat acorns are chiefly squirrels, dormice, and jays.

Beech-nuts. The beech forests also yield a rich, oily food. In the beech-nut the cupule forms a prickly cup which in autumn opens into a four-pointed

star-like form, within which are two shining, brown, curiously three-sided nuts. The sweet or Spanish chestnut has an extremely spiny cup, something like that of the beech on a much larger scale, and, like it, splitting into four pieces when ripe. In all the above cases the nut with its cupule is the *whole fruit*, and the seed is within.

In the horse-chestnut, as most boys know, the "nuts" are contained in a green, fleshy case, provided with blunt prickles. When it opens there is a beautiful colour effect in its snowy lining and glossy fruits. But these "nuts," we should observe, are not fruits. They are seeds contained in the seed-case—the fleshy capsule. There is no extra covering corresponding to the cupules of the hazel, acorn, &c. If we bear in mind the importance of watching the fruit *throughout* its development, these distinctions will be much less puzzling.

Neither are the walnut and the coco-nut "nuts" with cupules like the beech or acorn. The greenish-brown covering of the walnut, and the fibrous mantle of the coco-nut (usually stripped off before it is sold) correspond to the juicy pulp of the plum or peach. Let the children experiment a little with the stain of walnut juice, as they cut the case open to get at the double corrugated nut within. Walnuts used for pickling are gathered early in July before the hard shell has been formed: the part which we eat is the green pulp. The boat-like shape and light, fibrous packing of the coco-nut render it easy for the seed to float from one South Sea island to another, and the fruit forms an excellent starting-point for a most interesting lesson in geography.

Certain tribes of the home-land besides those we

have named are consumers of nuts. Deer feed upon horse-chestnuts, which many other animals dislike.

Wood-pigeons and beech-mast. Pheasants and wood-pigeons feed greedily upon beech-mast. In 1907 an epidemic occurred among wood-pigeons, and large numbers of them died. It has been sug-

gested that this was due to a specially abundant harvest of beech-mast in the preceding autumn. For the wood-pigeon, beautiful and tame as it is, has a reputation for extreme greediness.

CHAPTER XLVI

SEED SCATTERING

Nature's hoarding and scattering.—The main use of the fruit is to contain and protect the seeds *until* they are ripe. Hence the covering of pulp or wood or other tissue to protect the seeds from too much wet on the one hand and from too much dryness on the other. Hence the sour taste of unripe fruit. Hence also the wax or bloom on grapes, plums, &c., which also serve to keep out the germs of moulds which might settle on the flesh and spoil it. (Ask the children why fruiterers wrap choice fruit in tissue paper.) Hence the hip of the rose is guarded by downward pointing prickles on the stem and branches to protect it from climbing mice, though an advertisement of red colour is hung out for the birds when the seeds are ripe enough to be carried away.

But once the seeds are ripe, the main interest of the parent, as children will see by analogy from human affairs, is to place the offspring out in the world, and *not* in a locality that is already occupied to overcrowding. Now is the time when Nature's hoards, hitherto so jealously guarded, must be distributed, her treasures must be scattered. The pupils know what happens in the case of edible fruits. We must try still to maintain a point of contact in their experience, and instead of giving them an isolated lesson on the "Dispersal of Seeds," with a miscellaneous set of specimens, we should whenever possible let them watch and report

on seeding plants in their own garden or along the hedgerow; or, at any rate, confine the examples to such plants as have been seen as *wholes*, or such as present especial elements of interest, as is the case with the coco-nut, for example.

Seed scattering by animals.—The edible fruits are, as the pupils have seen, mostly carried away by birds or other animals. This may suggest the question:

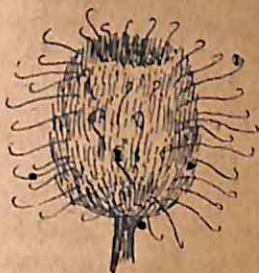
Seeds scattered in edible fruits, vide preceding chapters. In what other ways may animals carry seeds? Let them look again at the "bur" of a sweet chestnut, and see how easily the prickles would catch in the woolly back of a sheep, be carried to some distance, and then got rid of as the animal rubs itself against a fence. A sheep's fleece, as a matter of fact, is often full of seeds of one kind or another.

The common *goose-grass* (cleavers, or Robin-run-the-hedge) grows by every wayside, and children often playfully pelt one another with the green balls of the fruit. These tiny spheres are covered with small clinging hairs, which enable them to adhere very closely to hair or cloth or fur. At length the little seed-vessels break, and the seeds are scattered, perhaps, at a long distance from the place where the parent grew. The *burdock* has a set of bracts surrounding the composite flower. Each one of these is curved backwards into a hook, so that a whole head of flowers is sometimes carried away in the wool of a sheep.

By hooked fruits.

The little *wood forget-me-not* also has its long narrow-toothed, seed-vessel, well supplied with small hooks. The *wood-avens* (geum or herb-bennet), which is often mistaken for the buttercup, has a head of little fruits, each furnished with a sharp spiny cap, something like the awn of the oats, except that it has a crook in it. The sharp point sticks into the garment of a "human" or

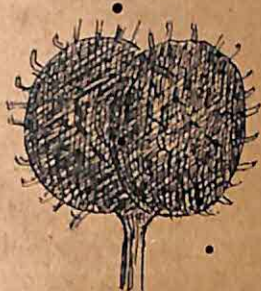
the feathers of a bird or the fur of a beast, and the crook causes it to cling so that it is only dislodged with an effort, and is often carried quite a long way.



BURDOCK



AGRIMONY



CLEAVERS



WOOD FORGET-ME-NOT

FIG. 58.—HOOKED FRUITS

**Seeds
carried in
mud by
birds.**

Children can easily realise how ducks, herons, wag-tails, and other water-birds often carry fruits or seeds sticking to any chance mud on their feathers or feet, or on their beaks. Thus it is that a pond newly dug in a field is soon populated with plants as well as with animals of different kinds.

Tell them how Darwin took $6\frac{3}{4}$ oz. of mud obtained in this way (show them roughly how much this quantity

represents), and found that no fewer than 537 plants germinated from it.

Seed scattering by wind.—But sometimes the plant prefers to trust to the wind rather than to animal agency. The common *poppy* is a good example; here the seeds are contained in a round, tough box, beautifully

Small light seeds. . . . ribbed on the outside and surmounted by a circular lid which projects over the sides like the eaves of a house. Below the eaves the capsule is pierced by a number of small holes. Let the children experiment with a ripe capsule, and see how easily, when it rocks in the wind, the seeds would be shaken out. These seeds are very minute, and so light that they are swung out quite a long way. They are also very numerous, and as they ripen just when the wheat also is ripe, they would be very mischievous, and give the cornfield more blots and streaks of scarlet than it has even now, were it not that the seedlings growing in little patches together, where the seeds have fallen, compete with one another for soil, light, and air, and only the strongest survive.

Some fruits and seeds, light though they are, provide themselves with contrivances which ensure their being wafted to a good distance. The *dandelion* is one of the commonest examples, and it is also one of the most beautiful. It is, of course, a composite flower, guarded by a double set of bracts on the outside of the whole "head." When the flower is young, the inner bracts are folded over the head and the outer ones bend backwards to keep off climbing insects. The flower opens in sunshine and closes at night and on dark days. In sunshine the little florets are lifted up on the cushion-like top of the flower-stalk, which on dark days becomes hollow or saucer-like, and so draws them in. After the anthers have given up their pollen to the flying insects who visit the dandelion

**Tufted
fruits and
seeds.**

in such numbers, the bracts again close over to protect the little fruits which have been "set" within, and the stalk meanwhile grows to a great height. When it is

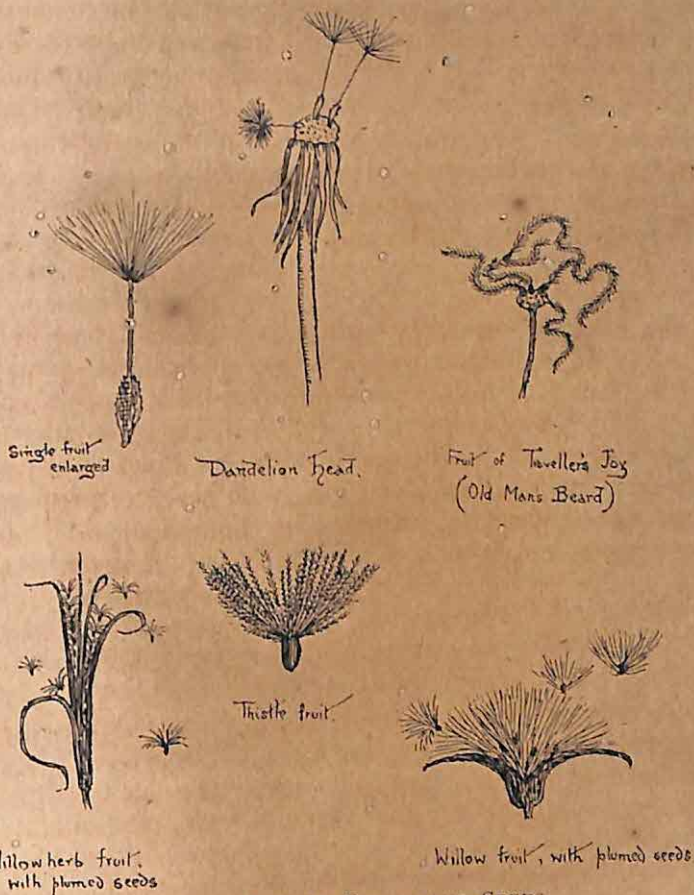


FIG. 59.—TUFTED FRUITS AND SEEDS

long enough to lift the fruit above surrounding grasses and leaves, the top of the flower-stalk again becomes convex—almost a perfect globe—and we see the spherical

head or ball of the dandelion "clock" ready to be blown away by the wind. The calyx of each little flower, instead of forming a green cup, has become a feathery tuft (pappus) which crowns the little fruit. (The fruit and seed adhere so closely as to be indistinguishable without a microscope.) The little pappus remains folded in wet weather, but in dry weather it acts as a parachute, and, after floating in the air, at last brings the seed gently to the ground, where the hairs help to glue it to the moist earth (fig. 59, p. 337).

A common hedgerow plant, the *wild clematis*, traveller's joy, or old man's beard, as it is variously called, has a feathered fruit. Let the children notice how this plant climbs. Not by its stem as the convolvulus or hop does, not by tendrils as the sweet-pea or vine, but by its leaf-stalks, which curl round any support that they have touched with their sensitive under-surfaces. The climbing nasturtium (*Tropaeolum*) in suburban gardens behaves in the same way. The cream-white flowers of the wild clematis are indeed a traveller's joy, and when the blossoms have fallen, each of the long styles, of which there are many in one blossom, shows as a curved feather which is almost equally beautiful. Thus are formed the white beard-like tufts which make such graceful knots and festoons along the hedges, until by-and-by the styles with the adherent fruits are scattered by the autumn winds.

In the case both of the dandelion and of the wild clematis the *whole* fruit is carried. In the case of the *willow-herb*, which grows as a weed in damp places and is also common in odd corners of suburban gardens, the fruit is a long narrow capsule, which, when ripe, splits open lengthwise, and shows within a number of little tufted seeds. Here the seeds have developed, as it were, an extra seed-coat of hairs for purposes of wind-transport. The willow-herb is so called because its

leaves are like those of the willow, and in this matter of seed-scattering also it imitates its greater namesake, for the seeds of the *willow-tree* lie in a tangle of hairs which, as they grow, force the seeds out of the seed-vessels, and then help them to float away. Willow-seeds ripen early in the summer, and the cottony hairs serve not only to carry them, but also to anchor them to the soil where they fall.

Many fruits, especially those of trees, develop wings which waft them through the air, often for long distances.

**Winged
fruits and
seeds.**

The form of the wing varies with each fruit. Thus the ash has one broad wing; the sycamore has two; the elm has one wing which surrounds the fruit on both sides. In the lime, as we have seen, the fruits are attached in a little bunch by a long stalk to a honey-coloured bract which carries them through the air in the fashion of a kite. The naked seeds of pine or fir, which are not contained in a case or fruit, are also provided with wings (fig. 50, p. 340).

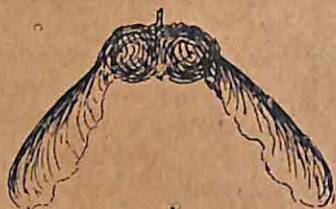
Water carriage.—Special arrangements have to be made for scattering the seed of water-plants. Sometimes birds help the process, as when they break open the fruits of the *water-lily* to get at the glutinous seeds, and, if disturbed, fly away with some adhering to their bills. But the water-lily seed also develops a special envelope or extra coat, not hairy like that of the willow-herb, for such a device would be worse than useless here, but like a lifeboat with water-tight compartments, so that it can safely float for a time. The *water forget-me-not*, unlike its wood relation, has a smooth fruit case. Why is this? The *coco-nut*, as we remarked in our last lesson, is admirably fitted both by its shape and by its packing of light, loose fibre within a waterproof rind for floating from one island to another.

Seeds scattered by splitting of seed-cases. In the *wallflower* and in the charming old-fashioned *honesty*, the

Lime fruit



Sycamore fruit



Elm fruit



Birch Fruit



Maple fruit



Pine seed



Hornbeam fruit



Ash fruit

Winged Fruits and Seeds.

FIG. 60.

children can see the sides of the seed-vessel (silique) coming away from the partition in the middle, leaving the seeds loose and unprotected, so that the wind can easily dislodge them. The fruit-case (capsule) of the little scarlet *pimpernel* splits across the middle so as to form a cup and cap—the cup being full of seeds, which can now be rocked out by the wind, as were the poppy-seeds through the holes at the summit of their capsule. The long narrow pockets (follicles) of the *columbine* open sideways, and the bladder-like seed-cases of the *pinks* and the *campions* separate into teeth at the summit, while the *iris* splits into three widely-separated pieces, showing the beautiful yellow seeds thickly packed within.

Seeds scattered by explosion of fruit.—Some dry seed-cases split, when ripe, in such a way as not merely to leave the seeds exposed, but to jerk them violently to a considerable distance. Children cannot often see this actually happen. But they can look at the dried pods of their *sweet-pea* plants and note that the seeds have been jerked away. And if they are sitting out of doors on a hot day, near a *broom* or *gorse* plant, they may often hear sounds such as might be made by a fairy popgun. This is the sudden cracking of the seed-pods of one of these plants. The two sides of the pod make a spiral coil, and the seeds are literally shot out and sent to a considerable distance. The teacher may also be able to procure and show to the children some nearly ripe fruits of the so-called "*American Balsam*" which is common in some gardens. A slight pinch at the tip of the pods of this plant will produce an explosion.

The *dog-violet* has three chambers in its seed-case, with a row of seeds in each. The walls become dry, contract, and at last squeeze out the seeds, which are smooth, pear-shaped little bodies, and speed like

miniature bullets through the air, often travelling several feet. The little pink *herb-Robert*, the wild geranium, is even more "cunning" in its devices. After the flower has faded, the style above the seed-case remains as a spiky rod. This at first hangs down, but when it is ripe it stands erect, the valves of the seed-case break away from the rod at the base, and in so doing the seed is slung out as from a noose in a string. Lord Avebury, who studied *herb-Robert* carefully, brought a ripe plant into the house and put it on a billiard-table, so that he might find how far the seeds travelled, as it was difficult to discover them in the open garden. They were slung, he found, from one end of the billiard-table to the other, and far beyond—a distance of twenty feet altogether. Let the children consider how much work this means for so slight a "weed" (fig. 61, p. 343).

Seeds scattered accidentally by man.—The pupils will be entertained by hearing how our common English weeds have been carried over the world by man himself, who has unwittingly enclosed their fruits and seeds in packing material, &c., and thus borne them in the holds of ships to countries where they have flourished, so as to become in some cases veritable pests. Thus we have disseminated the stinging-nettle, the dock, the sow-thistle, the shepherd's purse, and the common weeds of the cornfield; for, as Professor Miall points out, most of these weeds have very light seeds, are very hardy, are capable of bearing extremes of heat and cold, are capable of being self-fertilised, wind-fertilised, or fertilised by any good-sized insect they may find in their new country. This sort of consideration gives the children a respect for the vitality of seeds and a realisation of the responsibility of seed scattering.

Records and collections of fruits and seeds.—The collecting instinct can be very fitly employed upon fruits and seeds. Let the children make brush-drawings

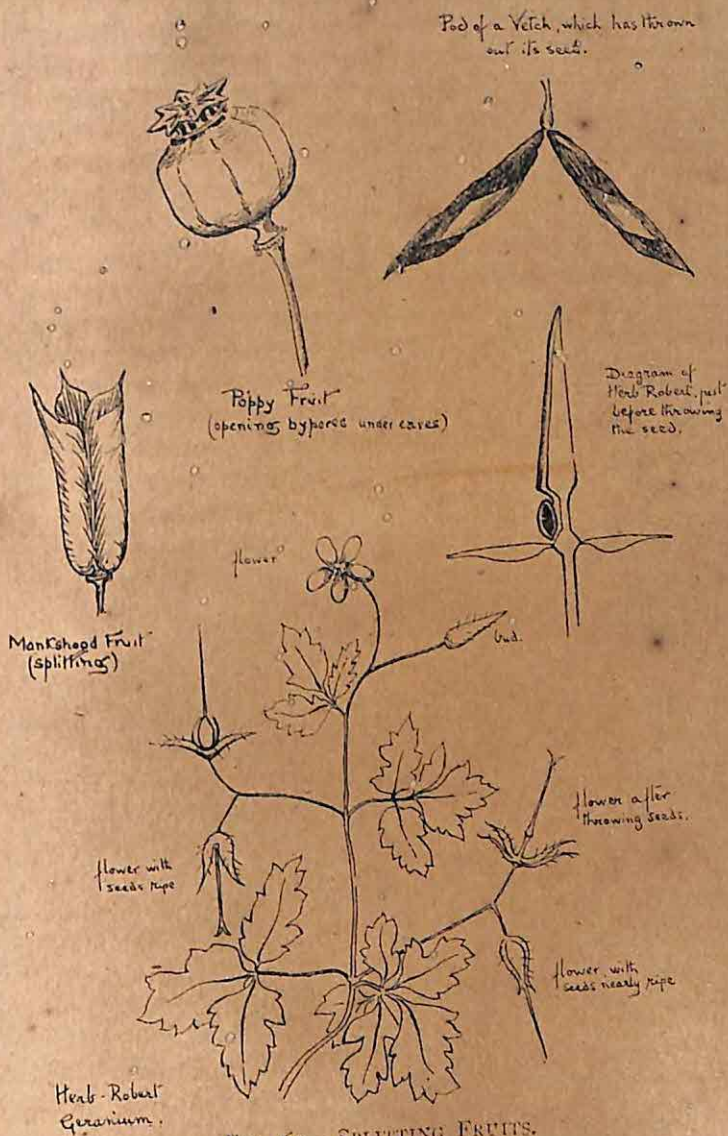


FIG. 61. SPLITTING FRUITS.

of coloured edible fruits and collections of dry fruits. Children of twelve will delight to make models of them—sometimes in clay or plasticine, sometimes, as in the case of winged fruits, siliquas, or follicles, in stiff paper with wire and gum as accessory materials. (It is scarcely necessary to say that paper-flower making for ornamental purposes is *not* advocated; the models are to be merely illustrations to bring out points of structure.) For fruits with pappus, &c., drawing is obviously the more appropriate medium of illustration. Collections of *seeds* may also be made. The seeds, if small, can be gummed on cards with the names printed below. Some may be kept in phials, or even in labelled matchboxes. A few seeds with perishable coverings, such as those of the yew and spindle tree, may be preserved by the teacher in alcohol, but not before a record of their colour has been made by the pupil in a brush drawing.

CHAPTER XLVII

PLANT OBSERVATIONS IN AUTUMN

AUTUMN, though it brings a diminution in the wealth of material afforded in the summer months, has, nevertheless, its own interests and problems. The children will be attracted not only by the fruit harvests, but also by the brilliant changes of colour in foliage leaves and by the fall of the leaves themselves.

The Virginia Creeper.—Town children will hardly fail to notice the rich tapestry of the Virginia Creeper which glorifies the dull brick house-fronts of the suburbs. The whole plant is very interesting all through the year. Let them notice how weak are its stems, and yet how high it climbs. Like the sweet-pea and the vine, it climbs by tendrils. A tendril may be a modified leaflet, as in the sweet-pea; but in the case of the Virginia Creeper, as of the vine and bryony, the tendrils are little branches which rise in the axils of the leaves as all branches do, but which, instead of developing leafy shoots, give out threadlike bodies with sensitive hooked tips. These tips expand into little broad discs which serve the plant as clinging hands. If the creeper is planted near a wire-work trellis, its tendrils twist round the wire, as those of the vine or sweet-pea would do. But when the tips lay hold, as it were, of the rough projections which we find in a brick wall, they swell and form the discs which adhere to the supporting surface. Even when the plant is dead, these discs cling so closely that it is very

difficult to remove them from the pits they have made in brick or cement. Darwin thought that the little discs give out some cementing fluid which helps to tighten their hold.

Let the children notice how all the leaves of the creeper turn outward to the light, and all the tendrils, with their discs, turn inward to the walls. If the plant is grown in a box, only one side of which faces the light, and is turned round so that the tendrils face the light and the leaves the dark, it will right itself, so to speak, until the leaves have all the benefit of the sunlight which is so necessary to them.

The American Virginia Creeper has a compound leaf, divided something like a horse-chestnut leaf, each leaflet suspended from the same point, and the foliage hangs out rather loosely on long stalks. Its Japanese relation (*Ampelopsis Veitchii*) has a smaller undivided leaf, with a cut edge, not unlike a vine-leaf in shape, while the leaf-stalk is shorter, so that the curtain of leaves clings more closely to the wall. The little discs appear in this variety before the tip of the tendril has touched the wall, as though they wished to be ready beforehand for their task.

Change of colour in autumn leaves.—Collections of leaves in their autumn tints can be made, and the characteristic colouring of each kind can be noted. Why does the leaf change its colour? the children may ask. A full reply involves some knowledge of organic chemistry, but the children may be reminded of what they have been told—viz. that the green substance of leaves manufactures food for the plant from gases contained in the air. The manufacture of starch is only possible in sunlight, so by the time the sunless days of winter have come, this work ceases. The materials produced in the green cells migrate, as it were, through the vessels to the storehouses arranged

by various plants for the purpose, to the rootstocks or bulbs of such plants as Solomon's seal or the onion; to the roots of biennials, such as the carrot or turnip; and in the case of trees, to the woody stems. Here they are stored until the following spring. The red colouring matter, which, with all its charming variations of orange, brown, purple, &c., appears in spring as well as in autumn, protects the tissues while this transport of materials is going on.

Fall of the leaf.—The leaf has now done its work; the green substance has disappeared, leaving only yellow granules, and the tissue ceases to be supplied with sap from the main plant. It is merely a dead framework supporting waste matters which the living plant cannot use. But these waste matters, if returned to the soil, would be converted into nutritious mould which would nourish the plant next year. Hence, it is well the leaves should fall round the parent tree. If they were left hanging they would catch the wind, and, as Professor Miall points out, the high winter gales would tear off the twigs likewise, and thus damage the tree.

Preparation for the fall of the leaf.—At the base of the fallen leaf of the horse-chestnut or plane the children will see a broad expansion or cushion which once clasped the stem. This served as a little thimble or hat to cover the tiny bud which is produced in the angle between leaf and stem. But just below this cushion was formed a layer of cork cells which actually seal up the vessels bringing food supply to the decaying leaves, and also prevent the leakage of sap from the stem when once the leaf has fallen. The horseshoe-shaped ring of scars on the horse-chestnut twig shows where this sealing of the vessels has taken place, the scars corresponding to the principal veins passing from the stem into the leaf.

Beyond the cork layer, on the side farthest from the

stem, other cells are formed, which break down when the leaf is dead, so that they separate the stalk from the parent stem.

Skeleton leaves.—The children will like to make collections of skeleton leaves, whereby they will learn by what a wonderful system of ribs and veins the delicate green tissue is supported. The leaves may be placed in a pan of boiling rain-water, and exposed for about six weeks in the open air. A quicker way is to boil the leaves for about two minutes, and then drop them into a strong solution, slightly warmed, of permanganate of potash (2 oz. for $1\frac{1}{2}$ l.), and in an hour or so the soft tissues may be gently removed with a camel-hair brush. This will, of course, turn the veins brown, but they may be bleached in a diluted solution of chloride of lime.

Signs of life in autumn.—The fall of the leaves and the bareness of the trees suggest death. Let the children, therefore, at the same time look out for signs of *life*, for winter does not mean death, but sleep. Near the scars left by a fallen leaf the new bud is seen closely

Buds. packed in scale-leaves. The sticky buds of the horse-chestnut are big enough to be seen quite early in the autumn just above the scar of the fallen leaf. The long, pointed buds of the beech show amongst the russet leaves which still hang; for the beech and the oak, curiously enough, do not lose their dead leaves so soon as other trees. And tiny buds are to be found on every bough, closely protected by their scale-leaves.

On the birch-trees, easily recognisable in autumn and winter by their graceful shape and silvery bark, will

Catkins. be seen the brown-papery catkins of this year, which crumble as one touches them, and also the hard green compact catkins of next year, closely covered by their overlapping scaly bracts. The

hazel and the alder also show their catkins, confident in the promise of spring, and the hardy annuals of the hedgerows, which dropped their seeds in late summer, have already seen their offspring germinate and spring up, a host of wild seedlings making a green carpet for the bank.

Sleep of the higher forms of plant-life.—For the most part, however, all the higher plants, except the evergreens, of which we shall speak in another chapter, have passed into what may be described as a resting-stage, comparable to the pupa or chrysalis period of insect life, or to the hibernation of certain animals. They are sleeping, just maintaining life on a very little expenditure of food, and hoarding all their store for the blossoms of next year. Their offspring, the seeds of the year, are for the most part dormant also, waiting for the warmth of spring.

Lower forms of plant-life.—But certain of the lower forms of plant-life are very conspicuous in autumn. The town child will see mushrooms sold in the shops, and their shape will attract him. Country children, exploring hedgerows, woodlands, or fields, will encounter strange shapes and colours which have sprung up as by magic, and the country teacher must remember to give his annual lesson on the differences between edible, harmless, and poisonous fungi. A "fungus foray" on a half-holiday is, perhaps, one of the best ways of managing this.

The question may come—What is a fungus?

It is a plant of very simple structure, which, having no green cells, cannot produce food for itself from air, water, or soil. It must, therefore, obtain its food from other plants or animals, living or dead. (Let the children notice where the fungi are found.)

They will be most interested in the mushrooms, toadstools, and puff-balls, and, perhaps, in the brilliant

fly agaric—vivid red with white specks. The common mushroom has a stalk-like portion bearing an umbrella-like top. From the inside of the umbrella hang thin plates or gills. Each gill is a mass of filaments which bear tiny bodies corresponding to the seeds of higher plants and called *spores*. These will produce new plants. Place a mushroom gills downward on white paper, and let the children see how in a few hours lines of spores will appear on the paper corresponding to the direction of the gills.

The umbrella form is not found in all mushrooms. Some are like brackets or oyster shells; these are often found growing on rotting tree trunks or stumps. The puff-balls are globular, and the little spores when ripe burst out from holes at the top.

Let the children notice the white furry growth on moist bread, jam, manure, &c. These are simple thread-like growths like those at the base of the mushroom stalk.

Fungi and hygiene.—Let them notice that dampness is a general condition necessary for the growth of fungi. Show them some yeast (or "barm"), and let them see how it multiplies in a sugar solution. Without going so far as Dr. Alex. Hill, Master of Downing College, Oxford, who half-humorously advised a teachers' conference to place large diagrams of magnified bacteria on the schoolroom walls in order to warn the rising generation into hygienic ways, we think that children of twelve ought to be told something of the minute relations of the fungi—bacteria, bacilli, microbes, germs, as they are variously called. The opportunity doubtless will come quite naturally. The other day a teacher opened a box of acorns which had been sent by post for her Nature-study class and found that the acorns had mildew on them. "How could it have come there?" asked the children. The teacher told how long ago in

her father's village a cup of barm or yeast would be handed round the village, and if a careless housewife spoilt it, the whole village would have to wait for bread until germs from the air caused fresh yeast to grow in a sugar solution. The spores of mildew came first in this "accidental" way. Some such germs are useful, as the yeast in this case; some are harmless; but many are dangerous. They settle in milk and render it sour, hence milk should be boiled; they settle in wounds and cause them to fester, hence air must be excluded. They cause disease in potatoes, turnips, wheat. (The so-called "rust" of wheat is a fungus which spends part of its life on barberry and part on wheat.) They cause diseases, such as tuberculosis, cholera, diphtheria, typhoid. Dr. Hodge, in "Nature Study and Life," tells how the print of an outspread dirty hand and of a clean hand respectively was taken on prepared plates of gelatine. In a short time the print of the dirty hand was found to be filled in with a dense growth of bacteria, while the print of the clean hand remained unaffected. Thus we come to enforce the lesson which can hardly be enforced too strongly—the necessity of abundance of clean air, *i.e.* air free from the living dust of dangerous germs, as well as habits of personal cleanliness.

Lichens.—During their fungus forays the children can notice the grey crust-like growth of the lichen, with the curious fairy-like cups on some of them, which contain spores. A lichen is an instance of curious co-operation in plant-life—a fungus and an alga keeping house together. The alga is a very simple green plant, such as compose the scum of ponds or the strips of seaweed on the shore, and being green, it can manufacture food for itself and for the fungus, which serves as a support and protection to it.

Mosses.—The mosses, too, especially the soft green moss like pile of velvet (*polytrichum*), will delight them.

Polytrichum shows slender stalks rising from the soft pile, at the top of which is a dainty urn-like vessel with an extinguisher or cap on it; again a spore vessel. Until a favourable day comes for shedding the spores, they are held in the capsule by a ring of little teeth which the sharpest children can see.

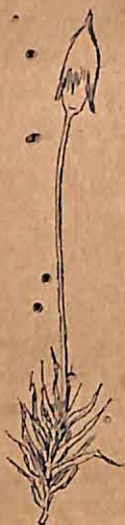


FIG. 62.—MOSS-PLANT; CAP STILL ATTACHED

Ferns.—The mosses, though they have no flowers, have stems and leaves, and the ferns are higher still in the scale of plant life. The great bracken fern will now be bronzed and limp, but in the spring the children will have noticed its big fronds coiled up like a crosier and protected by woolly scales. These fronds appear to be highly compound leaves, but they are not like the foliage leaves of higher plants, in that they have to perform somewhat of the function of flowers as well. At the back of the bracken fronds, within the in-rolled

margins, are groups of little brown bodies like watch-cases. These are spore-cases. A spore from the spore-case does not produce a fern at once, but gives rise to a little heart-shaped body (*prothallus*) varying in size in different ferns from a pin's point to a threepenny-piece, which is the parent of the actual fern. The teacher may be able to find the prothallus of some hot-house fern to show the children. Let them notice the different ways in which the spore-cases are arranged on the fronds of different species. Hartstongue (which has undivided leaves) and the common polypody are green all the year round, but most of the other outdoor ferns have followed the example set by the higher ranks of the plant world, and have gathered their stores of food into underground rootstocks for the winter.

CHAPTER XLVIII

ANIMAL LIFE IN WINTER

THE approach of winter often means famine to wild creatures. Help the children to observe or imagine what has become of the inhabitants of woods, fields, and hedgerows, and to find out the various devices they adopt for tiding over the unkindly season.

The animals cared for by man are safe enough. The food of cattle, for example, is supplemented by hay, roots, &c., and in the worst weather the cows are sheltered in the yards, and the sheep may be folded in a sheltered place under the hill, out of the reach of the prevailing wind.

The winter sleep of animals.—But the wild creatures, who have to fend for themselves, must find out other devices. The most economical way of spending the winter is obviously to sleep. The bat does this, and the hedgehog, and the squirrel and the dormouse. The bat sleeps more profoundly than any other of our wild creatures; indeed, it is said that if a bat be wakened from its six-months' slumber it will die.

Bats. The bat, by-the-bye, is a difficult animal to observe even in the summer. When the children notice it flying round the house or along a hedge in the dusk, they not unnaturally take it for a bird. This is one of the few occasions when the use of a stuffed specimen is legitimate. Let the class see that it has a furry body, in outward appearance like that of a mouse—it is, indeed, called the "Flitter-mouse" in

some parts of the country—and let them take its portrait in pencil to show the great membrane that stretches between the fingers of the hands, along the side of the body and down to the toes. The membrane forms a wing, and the bat is the only winged mammal we have. Bid them notice the difference between the flight of a live bat and that of a bird; the bat flies not in a straight line or a broad curve as a bird does, but in a darting zig-zag fashion. Account for this by telling them how the bat sleeps in the daytime, and at night hawks for insects and other small creatures, guided by its wonderfully acute senses of hearing, of smell, and of touch, and changing its direction as these give it notice of its prey. During the winter its food supplies fail, so it hangs itself up, head downwards, by its hooked toes, in some corner of a church tower or in a hollow tree and there sleeps, wrapped in its coat of leathery “wings.”

The hedgehog comes next on the list of sound sleepers. Its ordinary food is very general in character—toads, insects, snakes, earthworms—but it cannot get enough of these in the winter, and obviously it can make no hoard like the nut-consuming squirrel, so it rolls itself up into a spiny ball and makes for itself a warm bed under a drift of leaves in the hedge. Hedgehogs are sometimes tamed in order to keep down the abundance of domestic cockroaches, but even when the food supply is thus secured, the creature will disappear for a long time together, sleeping in some out-of-the-way corner.

The dormouse earns its name rather from the amount of its sleep than from its soundness, for it is easily roused in the tame state by a little extra warmth, and when out in the woods or hedges will wake up on sunny days in the winter, though it soon goes to sleep again. It has a cosy

nest made of strips of honeysuckle fibre, the coarser outside and the finer within, with a lining of leaves or moss. This is slung up in a bush at a height of from three to six feet. It appears to make little hoards like those of the squirrel, but its own store of fat accumulated before hibernating serves to replenish the slight waste of the body which occurs during the period of inactivity.

The squirrel, as every child knows, makes a comfortable sleeping-hole in the fork of a tree, his bushy tail serving as an overcoat. He, too, wakes up now and then, and remembering his thrifty stores in the autumn, betakes himself to one of his larders. The children may ask why he did not store his nuts in his sleeping-chamber, so that they might be conveniently at hand. But if he had done this, the frequency of his journeys to one particular spot might have drawn upon him the attention of one of those tigers of the English woodland—the stoat or the weasel.

Winter sleep of cold-blooded animals.—Snakes, as we might expect, pass the winter in a sleep. Their blood circulates so sluggishly and is so imperfectly oxygenated that the need for food only arises at intervals, even in summer, but a reptile, lying torpid, will live comfortably for half a year without food. The Greek tortoise, so often kept as a pet, gives us his company in summer only. He burrows in the earth and hides himself away during the cold weather.

Frogs and toads are also very sluggish in their habits, and they, too, hibernate, the toad in odd corners of a garden; the frog in a ditch, pond, or empty drain-pipe. A frog, indeed, may often be seen swimming in a pond even in mid-winter, but in frost it retreats to the mud at the bottom. As the children may know from their lessons on the behaviour of water

under different physical conditions, a pond seldom or never freezes at the bottom, although the top may be thickly coated with ice. The mud is really a comprehensive overcoat protecting from cold, and for the sake of greater warmth the frogs will lie huddled together. *Some* air is necessary, but a sufficient amount can be absorbed through the porous skin.

Snails, like reptiles or amphibians, hibernate in winter in sheltered places, and for a similar reason—viz. that

Snails. having so little animal heat, they would be in danger of perishing. They are fond of burrowing under stones, or even of making a tunnel under the ground, and many of them will be found huddled together under an empty flower-pot. The body is drawn closely within the shell, and the mouth of the shell is in most cases either cemented on to some substance to which the whole shell adheres, or a door or lid is secreted to fill up the opening. This door, though a protection from frost, is porous to air and slightly porous to moisture, which the snail needs. The large Roman or edible snail, found on the chalk, is the best example for showing the lid.

Water-snails, like frogs, seek the mud at the bottom, though in ordinary weather a few may be found moving in a leisurely way, over the surface of the water, or hanging head downwards just below the surface by the thread of mucus which they secrete in order to suspend themselves.

Water-snails. The wintering habits of birds.—*Birds* have an advantage over other creatures in that they are warm-blooded and also extremely active. The warm temperature implies that a constant food supply is a necessity, but, fortunately, when it fails in one region they can seek it in another. The insect-eating birds, whose soft bills and wide mouths do not fit them to pick up grain, would starve if they remained, and it is these

birds—such as the three tribes of swallows and the swifts—who have special powers of flight. Consequently, these birds depart south directly the supply of insects begins to fail. The Emigrants to the south. swifts, indeed, leave in the middle of

August, before want comes upon them, and the cuckoo goes even earlier. Some of our native birds, however—the blackbirds and the thrushes and the robins—have learned to supplement their insect diet by seeds, and these, as well as the finches, are able to find a living at home, though many of them travel to the south of France and other Mediterranean countries—a less distant bourne than that of the swallows and swifts. Stay-at-home birds.

Native birds may migrate also from one part of their own country to another. London children, for example, see the black-headed gulls on the Thames or other waters very soon after the first frost. But England, inclement as it would be for the swallows who are now sunning themselves outside some Syrian town or in winter resorts along the Nile, seems as mild as the Riviera to birds of northern countries. Wild ducks, wood-

Immigrants from the north. cocks, and foreign thrushes, such as the fieldfare and red-wing, and the loud-voiced missel thrush or storm-cock—so-called because he sings loudly through a tempest—are among the more common of these winter settlers, who will return to their northern homes when the summer comes. The fieldfares especially are very common, and may be seen in flocks in the ploughed fields, along the hedgerows, and even on the open commons near London.

Birds of passage. Besides the birds that migrate to us and from us, there are birds of passage—i.e. birds who, passing from the north to climates farther south, rest with us for a day or two. In the lonely marshes on the coast these strangers are

often noted, and also too often shot. Help the children to imagine the flocks of wild birds flying high overhead, across the sleeping towns at night. Tell them the story of the bird records of the Heligoland lighthouse, against whose lighted windows so many of these mysterious wayfarers dash themselves in their flight.

Insect life in winter.—We have spoken of the disappearance of insect life in winter. This is certainly most marked. The swarms that filled the air in summer have apparently all disappeared. What has become of them? Untold myriads have been ruthlessly devoured by birds or their nestlings, and myriads have perished naturally, after a very short life, sometimes lasting one day only. Here, perhaps, may come in a difficulty,

**Problems
of death
and pain.**

which often recurs in Nature study. In older books on the subject, written as much for edification as for information, children were often called upon to admire the goodness of God in fitting the larger creatures with organs adapted for the destruction of the smaller. The writer well remembers a lesson on the woodpecker given to a class of young people by a sincerely good man, who, after explaining the mechanism of the sticky and barbed tongue so well fitted for catching and destroying insects, made this the text of an almost impassioned outburst on God's goodness and wisdom in the fitting of the woodpecker for the life he was to lead. The question was inevitable—"Does God, then, care not for the insects?" It is a dangerous thing to let children imbibe the idea that the lowly organised creatures are without the circle of God's care. These things are relative, for when the child comes to learn the insignificance of man himself in the material universe—when he learns to view himself as the puny and short-lived denizen of a planet which "spins like a fretful midge" amid vast and countless worlds, is he not in danger of despairingly placing

himself in the category of the unregarded insect? It is far better and safer, we venture to think, when the time comes for the child to be startled in the presence of the mysteries of pain and death, to tell him that these things are—we know not why—but we believe that they are ordered by the wisdom of God, Who has revealed to the soul of man, in the higher regions of his experience, that suffering is a necessity, which runs through all life, and which can be seen, in some cases at least, to have a blessed outcome. The Greatest Teacher knew that the sparrow falls to the ground, but not, He added, "without your Father," and this must be enough for us. Lessons from history show that death has not seemed an evil, but rather a privilege to many good and great men—may not this lessen the apparent horror of death in Nature? We must remember, too, that as in history, so in Nature, tragedies are the exceptions, and not the rule, that violent deaths are most often mercifully swift and painless, and finally that a vast majority of the animals, as of men and women, die quietly in their chosen homes when their time comes.

How insects spend the winter.—Many of the insects survive through the winter, even in the perfect form, otherwise where would be the abundant insect life of the coming year? The honey-bees are huddled together in their hive, subsisting on the small supply of food left to them, and the humble-bee is hibernating in her nest in the earth. The queen wasp, who is to be the mother of next year's brood, has retreated to a snug place in the ivy, and she may come out for a few hours on a sunny day, perhaps to perish. If she survives, she will retreat again until April or May; then she will emerge, bite off tiny bits of wood from a fence, chew them into paper, and make with it a wonderful domed and chambered nest as a nursery for her little ones. Ants and beetles are

In the
perfect
stage.

tucked away in the warmest corners they can find, in faggots, in corners of barns, under dead wood or *débris* of any kind that will shelter them from frost. Many a fragile butterfly, which is really a *late*-hatched butterfly of this last summer, is resting with folded wings in some dark warm nook, to be hailed as an "*early* butterfly" of some bright spring day, when she will come forth, lay her eggs, and produce a fresh brood of early caterpillars. The late caterpillars of the summer

In the
pupa
stage.

have spun soft cocoons or fastened themselves within hard pupa-cases. Here, slung in all kinds of crannies, where birds are not likely to find them, or buried around the roots of trees on the sheltered side, they will rest until spring. Children with sharp eyes and a great deal of patience will find pupa-hunting for the school breeding-cages an excellent form of winter study.

Death, life, and sleep in Nature.—Let the children imagine all this sleeping or quiescent life, roots, bulbs, tubers, lying underground, the bare trees quietly hoarding their resources, the unseen creatures sleeping or hiding in hedges or woodland. Some have fulfilled the law of their being, and perished; but this also is well, as much a part of the Divine purpose as the awakening life of the spring that is to come.

CHAPTER XLIX

EVERGREENS.—(I) CONE-BEARING TREES, PINES
AND FIRS

The meaning of "evergreen."—The children will not fail to notice that some trees, instead of dropping their leaves in autumn, remain green all the year round. They are apt to imagine that the leaves of such trees are perpetual, hanging on through the whole lifetime of the parent stem. Direct their attention to the abundance of shed leaves in a pine wood, or to the litter of brown leaves under the hollies in May, so that they may realise that the evergreen leaves do not last indefinitely. The difference between the evergreens and a tree such as the plane is that, whereas the plane sheds all its leaves at one season, the pines, hollies, &c., drop theirs gradually as the new ones are formed, so that there are always green leaves enough to clothe the tree.

Characteristics of evergreen leaves.—Plants which keep their leaves through the winter must have some special arrangements to enable them to endure the stress of winter weather. Let the children notice in the first instance the thick, firm texture and glossy covering of the laurel leaf. The laurel is not a native of England, but comes from the Mediterranean countries. It survives English winters in shrubberies and other sheltered places because of the firm texture of its leaves, which keeps in the moist sap of the tissues. What other shrubby plants have we? (Myrtle,

rhododendron, &c.) What kind of leaves have they? But the laurel and the rhododendron do not grow in open, windy situations where their leaves would be robbed of their heat and moisture by the surrounding air.

The Scots fir (pine).³—Contrast these partly acclimatised plants with the Scots fir, which can be rendered familiar to both town and country children, for it can be found growing almost anywhere, in exposed situations and on poor soil. It flourishes on the upland heaths and commons round London; the well-known groups on Hampstead Heath have often been painted and are now reproduced on picture post-cards. The Scots fir is not really a fir, but a pine (*Pinus Sylvestris*). Pines differ from firs in the way in which their leaves or “needles” are arranged (*vide* fig. 64, p. 375). The Scots fir has very much longer needles than the Christmas tree (which is a fir), and they are arranged in pairs on little spurs which shoot off from the main branches.

**Its leaves
and their
adaptations.**

When they fall, each pair of leaves may be seen to be bound together by a little sheath at the base. Some of the foreign pines seen growing in parks have their leaves in bundles of threes or fives, but the twofold arrangement, such as we see in the Scotch pine, is the most common. The two members of the pair look as though they might have formed halves of one pencil-shaped leaf which had been slit down the middle, for they are flat, slightly grooved on the sides facing each other, and rounded on the farther sides. They are from two to three inches long and of a very dense purplish green. They do not fall until they have been on the tree four years. Let the children notice how very well adapted are such leaves to grow on trees which have to endure wind, rain, and snow. The small narrow leaves, joined firmly together and close against their stem, merely move

with the whole bough like bristles on a brush that is waved up and down; there is no broad flat surface such as that of a lime or plane leaf to be rent and frayed or jerked away. The texture is hard and leathery, so as to keep out the wet, and the teacher will also be aware how the stomates or breathing organs of the leaf are protected so as to guard against loss of the tree's own moisture by excessive transpiration. The ordinary British trees escape this danger by dropping their leaves altogether instead of modifying them as the pine does. Again, if the pine had expanded leaves like those of the plane, a heavy snow-storm would deposit such a weight of snow upon them as to break down even stout boughs. But very little snow can lodge on the slender needles of the pines, and a gust of wind soon shakes them clear. A common illustration consists in pouring rice or other grain upon the closed finger of a child, and then through the open fingers; the child sees how it is that the narrow leaves prevent the snow from finding a lodgment.

A well-grown Scots fir (pine) can be at once distinguished by its stem and general shape. The stem is bare for a long way up the tree, for the lower branches die as the tree grows, and we can see the peculiar reddish colour of the flaky bark. We can note, too, how twisted and bent are the branches, especially if the tree grows in an exposed place, where it has had to wrestle with the wind. It is not that the branches are really "blown on one side," but that on the side exposed to the spring cold winds the buds are checked as they sprout, and the branches develop as they best can, in an irregular unsymmetrical fashion. The top of the tree often spreads out into a mushroom or umbrella shaped mass of very dark foliage.

This sombre tree, strange as it may seem, has its flowers.



FIG. 63.—SCOTS PINE

In May or June little staminate catkins threw out showers of golden pollen, which were carried by the wind to the little cones which had already formed on the new shoots. Tell the children of the abundant showers of pollen which were formerly mistaken by country people for "sulphur showers." The cones were then soft and of a pinkish-purple colour, standing erect. The bracts gaped open when the pollen was ready to enter, and afterwards closed again. Then they hung down and gradually ripened into the hard

Its cones. woody plates or scales which we see in an old cone, but they are not fully mature until they are two or three years old. Thus we may find cones of different ages hanging on a tree at the same time. The cones of the Scots fir are stout and solid-looking in the period before they are fully ripe, like one solid piece carved out in raised angular plates. When they are ripe the scales open at their thickened edges. Each of these scales carries on its upper surface two seeds. The whole cone may be compared to a set of eaves spirally arranged, each of the eaves protecting

Its winged seeds. two seeds. Each seed has a brown wing three times its own length. These are like the winged *fruits* of ash or sycamore, but whereas the seed of each of these has a covering membrane, and is therefore contained in a seed-vessel, which constitutes it a fruit, the seeds of pine are *naked*, and have no protection beyond that afforded by the woody bract (fig. 60, p. 340).

The children are fond of gathering pine cones for playthings or for fuel. By chance they may find still remaining under its bract one or more of the little winged seeds which have not been wafted off by the wind. A very large number of them are produced by the whole cone. Let the children compare the cone arrangement with that adopted by the apple or poppy, which enclose their seeds in an enveloping case.

The spruce fir.—If the children have noticed a Scots fir (pine) throughout the year, they will have a basis of comparison with the "Christmas tree," which is a true fir. The Christmas tree is generally a sapling or an upper shoot of the Norway or spruce fir. The Christmas tree, miniature as it is, gives the children a good idea of the shape of the trees as they grow on their native mountains. The broad branches grow, in young trees, quite near to the ground, though these die away as their younger brethren above deprive them of light and air. The next tier of branches is shorter, and so on until at its apex the tree is pointed like a church spire and the whole outline is sharply triangular. Breadth is sacrificed to tapering height, which is an advantage in countries where snowfalls are heavy, an arrangement imitated by the northern nations in their high-pitched roofs.

The leaves are narrow and four-sided, of a paler yellow-green than those of the Scots pine, and not nearly so long —not more than $\frac{1}{4}$ inch in length. The upper ones lean down on to the stem as it were, while the side ones stand out so that the whole stem has a flattened look. The leaves do not come off in distinct tufts or brushes like those of the pine or larch, but they form along the stem what Professor Miall describes as a "double comb" (fig. 65, p. 375). The whole tree has a characteristically trim appearance; the children may be reminded how we ordinarily use the word "spruce" (fig. 64, p. 368).

The cones are much longer than those of the pines; they measure from 5 to 7 inches. The fir cone is composed of bracts which do not seem so closely welded together as those of the shorter and stouter cone of the Scots fir (pine), but which hang neatly over one another, like tiles on a roof. The bracts are also somewhat more papery in texture; their edges are not thickened, and they are of a richer and



FIG. 64.—SPRUCE FIRS

more glossy brown colour. The cones stand upright at first, but when they are ripe they hang downwards to let out the seeds, which ripen in a single year—much sooner than those of the Scots fir.

If the children are taken into a fir wood they will notice how little light can penetrate between the flattened stems with their covering of thick dark leaves, which, though individually small, form a fir wood. collectively a thick screen. They will notice the network of roots, running close to the surface. The fir-tree grows on soil so thin and poor that its best policy is to spread abroad for nutriment rather than to explore deeply with no result. Firs and pines like to grow together in dense brotherhoods, on the mountain sides, in clumps on the moorland or common; their roots interlock and give support one to another. A fir wood even in summer is singularly silent. An occasional jay or woodpigeon may be heard, and a squirrel seen flirting up a tree, but generally it is a temple of solitude. Nothing grows on the floor of a fir wood except the bracken fern. This may be because of the resin in the loose, yielding carpet of needles at the foot of the trees.

The children will like to know that "fir-tree" really means "fire-tree," because the resin in the wood makes it so useful for fires and torches. They can often see the gummy drops of resin oozing from the trunk, or glistening on the cones and needles of a pine or fir. This is a good opportunity to tell them of turpentine, Products. wood-tar, "Sanitas," frankincense, and other products of the cone-bearing trees, and also why sanatoria are built in pine districts. Help to dilate their imagination by telling them how the desks at which they sit are made of pitch pine, and how the common deal, of which they see so much, comes from the firs which grow on the Norwegian hills, and how

so many of the matches consumed in English homes are furnished by the waste material of the trees that once tossed their branches in solitary places far away from human dwellings. For beauty and for use man owes much to the conifers—the most universally distributed of all the tribes of the trees. The teacher who would realise what may be called the *character* of the pine and the fir should read Ruskin's praise of them in "Modern Painters."

CHAPTER L

EVERGREENS (2)

Foreign pines.—It must be admitted that pines and firs are apt to be a little puzzling to the beginner, because so many foreign varieties have been planted in England. Thus the children may come across the Pinaster or Cluster-pine, originally a Mediterranean tree, which is often planted in sandy, heathy land in this country. It has very large brushes

Pinaster. of long narrow leaves, 6-12 inches long, which are much paler than those of the Northern pine or Scots fir, and which are borne upon the ends of the shoots while other portions of the branch may be bare. The cones have large lozenge-shaped bracts, each with a kind of boss in the centre, something like the umbo of a mussel-shell. They also crowd in a cluster; hence the name Cluster-pine. The name "pine aster" (aster=star) may have been given because of the starlike arrangement of the radiating needles, or of the points of the cones seen as we look up to them, or it may mean merely a variety of pine (cf. the word "pilaster" from "pillar").

The silver fir is a relation of the spruce-fir. It has a pale silvery bark and also a white line along the under side of the leaves. Its cones stand erect and do not drop off as wholes, but fall to pieces while hanging on the trees.

Many varieties of *Coniferae* are found growing in ornamental gardens, for the conifers are an enormous

family, clothing the hillsides of countries far removed from one another on the map of the world. At Kew or in the parks the little Londoner may see the dome-topped

Conifers at Kew. stone-pine with its big solitary cones, the deodars from the Himalayas, the cedar from Lebanon, and the "monkey-puzzle" tree or Chilian pine, with its sharply pointed overlapping leaves. Pictures of the big California pine are often seen in advertisements, and will help the children to realise the importance of the conifers geographically and economically.

The cypress and its relations.—In English cemeteries and in old gardens, the children may see the cypress planted as a symbol of immortality, partly because of its fresh, evergreen appearance, and partly because of its upward-pointing flame-like spire, for, unlike most other conifers, the cypress boughs tend upwards and not sideways. The children will take each frond-like spray for a single leaf, so they must be shown how every apparent scale is really a tiny leaf. The leaves crowd together so closely that they overlap the stem in dense rows. The apparent leaf-stalk, it will be seen, is really the branch covered with the scale-like remains of the old leaves. The new and old cones on some cypresses, and the tufts of staminate flowers on others, grow low enough for the children to see them. The cone is lemon-shaped, composed of about a dozen large woody bracts, which protect the seeds.

The arbor vitæ, a relation of the cypress, is very common in gardens and shrubberies. It is much like the cypress, but its branches are not so close and dense, and its leaves are not packed quite so closely together. It is difficult to distinguish them unless a spray of each is placed side by side.

The juniper, another relation, is likely to be known

as a wild plant especially to children in the north of England; it is very common along Tyneside, but it is low growing, a bush in fact, with short narrow leaves arranged in groups of three. Its cone is singular in that the ripe scales unite and form a so-called "berry." The children will like to know that the lead pencils sold to them as cedar-wood are really made of juniper-wood.

The cedar of Lebanon, on the other hand, is a conifer which always impresses us with its solemn majesty. When we analyse it to see what are the elements that make it so imposing, we find it is not the height, for in this country, at any rate, it does not tower upwards to any extraordinary degree, but the enormous length of its level outspreading branches, which form dense horizontal layers outwards from the trunk. Even the top of the tree is flattened rather than spire-like or dome-like. The tufted leaves are individually very small, but they are so many that they form a dense shade. The catkins are reddish and the young cones purple, though they become brownish as they grow older. The cones stay on the tree a long time, and it is characteristic that they continue to stand upright. The scales drop away from the cone when it is ripe, so that the children will not find the complete cones lying under the tree. Cedars are long-lived, but not near the smoke of towns, so that the specimens seen in the parks, or even at Kew, are not likely to have the length of days their brothers enjoy on Mount Lebanon.

The larch is a cone-bearing tree which, unlike those we have been considering, is *not* an evergreen. Its leaves drop in autumn, and we see its long yellowish-brown branches, drooping downwards, with just an upward curve at the tip, stretching out forlornly through the winter. Closely perched as it were on the branches are rows of cones—

cones of all ages—some ashy-grey with age, and some purple and green, of this year's formation.

With the spring come the leaves, of the palest, brightest emerald green, appearing in radiating tufts of fine needles on the short spurs given off from the branches, and making a charming contrast with the "rosy plumelets" of which Tennyson sings. The rosy plumelets are the little crests of pistillate flowers, shaped something like a pineapple, which are to form the cones of the year.

The *yew* is often seen in churchyards, perhaps because of its long life, for Tennyson hardly exaggerates when he speaks of its "thousand years of gloom." It is like the spruce fir in the flattened arrangement of its stem, for its leaves, which are broader and flatter than the needles of the fir, stand out right and left from the twig in a double comb. But it is unlike the pines and firs in producing a fruit which is more like a berry than a cone. Its seeds are borne singly, and each is partly sunk, when ripe, in a beautiful ruby-coloured cup, or "aril." The cup, though of a sickly taste, is not poisonous, but the seeds themselves should not be eaten. The pollen which fertilised the seeds came from another tree, which bore tufts of stamens only, and no pistillate flowers. The yellow pollen is so abundant that, as Tennyson says, the twigs respond to a "random stroke with fruitful cloud and living smoke" (fig. 65, p. 375).

The *box-tree*, which makes border edgings in old gardens and grows so well on Box Hill, is not a conifer, but a relation of the little spurge, whose cup-like bracts and bitter juice are so well known. It has spikes of pale flowers in April or May; and its fruit is a purple capsule crowned with little horns, which splits into three and throws out the seeds in an explosive fashion.

The *holly* is perhaps the most common of all ever-green trees, and as Christmas approaches the children will study it with special attention. Let them notice its

height (10-30 feet). The boughs of a well-grown holly are not leafy all along, but only towards the end. They

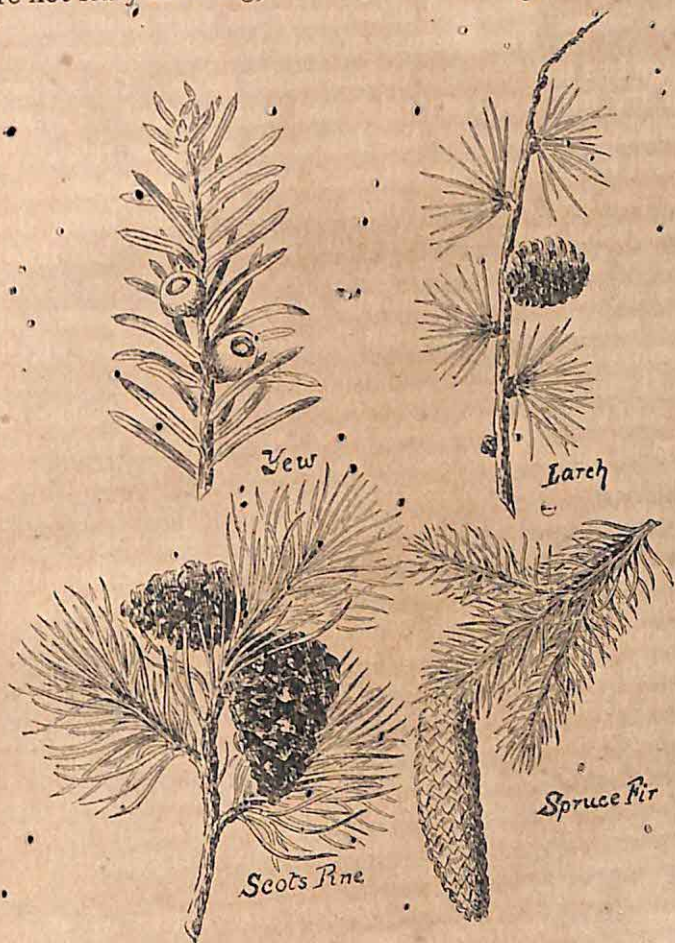


FIG. 65

seem to be thrust out like gaunt arms towards the light, and with the light comes the profusion of leaves. Roughly speaking, the form of the tree is pyramidal, so

that the higher branches do not overshadow the lower ones. Let the children look at the leaves. These are arranged alternately, on very short stalks. **The leaves.** The shortness of stalk is evidently an advantage to a tree that has to face winter gales. The surface of the leaf has been thickened and polished. Let the children skeletonise the leaves to see how relatively stout is the framework of veins, and how the whole edge of the leaf is doubly thickened, the spines being the drawn-out portions of this thickened border. Let them notice how most of the leaves on the tree droop downwards, so that the rain can run along the groove of the midrib and drip from the end of the spine which terminates it.

If the children are on a common or near the hedges of a field where cattle graze, they can be helped to see the use of these spiny leaves to the holly. Without this protection the tree would soon be devoured by rabbits, donkeys, and other grazing animals. But these creatures have soft noses—a donkey's nose is perhaps the most velvety thing one can touch—and the spines of a well-grown tree deter even the hungriest donkey, who cannot grasp them as he can thistle-leaves. It is worth while noticing that on the higher parts of the tree, where the leaves are safe from attack, spines are rarely developed. It may also be pointed out that a holly seedling, whose leaves are soft, not prickly, is rarely seen except in a hedge of brambles &c., or amidst a clump of furze on a common where it is protected by its formidable neighbours.

The holly-leaves are renewed every two or three years. In the spring many of those now on the tree will be lying round its base, crisp and brown. The new leaves are soft and their spines are not stiff enough to hurt, but they are protected by the older ones. Moreover, the grazing animals have at this time of the

year a good choice of tenderer and juicier herbage and leaves, and would naturally pass by the hollies.

The scarlet berries, enhanced by the dark glossy green of the leaves, are intended to attract birds. The children will find four "stones" amid the pulp—these are the seeds. Birds will carry the fruit away to eat, and the indigestible seeds will thus be dispersed.

The history of these berries should be traced back to the flowers of the holly, which were seen on the tree from May to July. They were in small white starlike clusters, between the base of the leaf and branch, just where the berries are now. There were four little sepals, four white petals, four pollen-bearing stamens, and in the midst of these the green egg-shaped pistil which becomes the future fruit.

Some hollies show no berries. These trees had imperfect pistils in their flowers, but instead they produced large quantities of pollen, which has fertilised the ovules on some other tree.

Other evergreen plants.—We have by no means exhausted the list of our evergreens when we have enumerated the trees, or even the shrubs. There are many wayside flowers and weeds which, sheltered by the hedge, keep their leaves through the winter. And plants that grow on peaty moorlands, such as the whortleberry, ling, and heather, are able to endure the cold by thickening their leaves or by rolling in their leaf-edges. There is always something green in an English landscape even in midwinter.

CHAPTER LI

A WINTER WALK.—COMMON; RABBIT WARREN

Vegetation on a common.—If the children are taken for a winter walk, a common is perhaps the most interesting spot to choose. Let them notice what kind of plants grow on commons. Hollies, gorse, and brambles are the most abundant of the larger kinds. These are evergreens—for the bramble may almost be considered as an evergreen—and they are also prickly plants. Help the children to realise why this is so. A common generally means a place where people may permit their cattle to graze at large, so that in the course of long years everything not prickly has been nibbled away. These survivors make pleasant patches of green for the eye to rest upon in the winter. And even in January the common shows *flowers*, for the golden butterfly-shaped blossoms of the gorse, whin, or furze, as it is variously called, may be seen gleaming here and there. So beautiful a plant it is that most borough and county councils have taken care to preserve the clumps that grow naturally in the open spaces under their care, and therefore even a town child can make its acquaintance.

The gorse plant.—The gorse appears to be always in flower, but this is because there is really more than one kind: the larger, which through the winter from October or November puts out a few blossoms here and there in periods of bright weather, but flowers with most magnificence in April or May; the smaller kind, which bursts forth and makes a new

display during the summer; and, appearing between the two, there is the "petty whin," a low-growing kind which flowers in September.

The spines will arrest attention at once, for the whole plant seems a mass of sharp green spikes. Cut off some twigs with a stout knife and let the children notice these spines more carefully. They will find that

Leaves. some of them are long and stout; these are branches, and the smaller spikes growing

from the sides are long, narrow-pointed leaves. Both stem and leaves are evergreen, so that the plant can make food for itself all the year round. The leaves are not too difficult of mastication for donkeys, but they cannot be reached because of the longer and more formidable branch-spines which are thrust outwards to guard them. The spines towards the tips of the branches grow outwards, while those lower on the stems are directed downwards so as to keep out climbing mice. Let the children notice how the whole "habit" of the plant—its bushy form, its tough stem, its hard, narrow leaves—is adapted to the wind-swept places in which it generally grows.

The flower-buds are well taken care of between the main stem and one of its short, stout spines. An insect

Flowers. mother in late autumn would doubtless like well to lay her eggs among the soft,

yellow petals, where there would be plenty of food for the young ones when hatched. But the gorse seems as though it foresaw such accidents, and wraps its five soft petals in a case of hairy brown sepals. There are only two sepals, but the children may as well note the five teeth which may be seen in the calyx, and which, as the teacher will know, represent the five separate sepals which have now arranged themselves into a pair of lips, as being probably the more convenient method of forming a purse or bag for the petals. The hairs on

the outside form a miniature thicket, through which insects cannot penetrate, and they are also like a fur mantle to keep the little blossom warm. Even the colour helps, for brown, as the children know, is a common colour for fur. It absorbs any heat there may be in the air, and gathers it in for the benefit of the creature who wears it. But some insects are

**Bee-
visitors.** welcome visitors, for they carry away pollen from the heads of the stamens in the centre of the flower, and when this is laid on the stigma of another flower, new seeds can be produced in the second flower. The gorse, therefore, tries to attract such insects. It shows a bright, yellow colour, and also throws out a delicious nut-flavoured scent. This will be noticed especially in April or May, and it is then that the children should be urged to get up early and watch the bees at work. The bee settles on the keel or the boat-like structure formed by two of the lower petals, and his pressure releases the stamens which are enclosed inside it. They spring up and dust him all over with pollen. This he carries to another flower, where he is brushed by the overhanging stigma, which thus receives his pollen. When the flower has been "sprung" open and the pollen all removed, the sepals fall back, so that an observant bee does not visit such a flower, knowing that his labour will be useless. Contrary to the custom of most flowers, the petals do not fall off, but remain to protect the seed vessel from the cold winds until it is quite ripe.

Each little pod, moreover, is covered with fur; this is not only to give shelter from cold, but to baffle insects who would like to lay eggs there.

Fruit. The children will remember that in the garden-pea, which is not so well protected, insects do sometimes succeed in making provision for their offspring at the expense of the peas, as we discover

when we "shell" them. On the plant the children will see the dried and blackened pods in various stages. When the seeds are ripe, the sides of the pod contract and pull against the thickened edges to which the seeds are attached. If the day is warm, they will shrivel up so suddenly as to jerk the seeds to quite a long distance. On a hot day one often hears a noise as of fairy pistols being let off—these are the beans being suddenly set free, and fired, as it were, out into

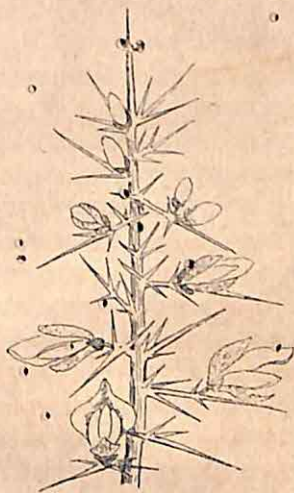


FIG. 66.—GORSE PLANT

the common or into the midst of a clump of bushes where, if they are fortunate, they will begin life on their own account.

A young gorse, by-the-bye, has leaves which are soft and three-lobed, something like those of its relation the laburnum; but as the plant grows, these **Seedlings.** trefoil leaves are replaced by the long, sharp spines. The teacher will not leave the gorse-bush without telling the children the story of the great

Swedish naturalist, Linnæus. This man gave his whole life to the study of plants, and has taught us more about them than any other man. The plant does not grow in his native district, and when he saw its golden masses and breathed its delicious fragrance for the first time, he knelt down on the turf beside it and blessed God for having made a thing so beautiful.

Broom.—Let the children look on the common for the relation of the gorse—the higher-growing broom. It is much less spiny, and has very long, slender, up-standing branches of a brighter green than those of the gorse. The flowers, which are not seen in the winter, are larger and brighter, though fewer than those of the gorse.

Birds of the common.—In summer gorse-bushes are the favourite haunts of the linnet and of the pretty summer visitors called, respectively, the stone-chat and the furze-chat, who are constantly seen perching on the branches. Goldfinches also haunt the common near the furze-bushes, and may be seen, even in winter, daintily feeding on the seeds of thistle and dock which have not been blown away by the wind.

Rabbits among the gorse.—The slope of a sandy hill on which gorse-bushes grow is a favourite spot for a rabbit colony. In such a spot Bunny is sure to find plenty of the short herbage he likes, and as it is not under cultivation there are no traps. Now, the young shoots of gorse, as we have said, are not prickly but tender, and are good to eat. It has been pointed out by Grant Allen, in one of his "Moorland Idylls," that "the very shape of the gorse-bush, which in such situations is like a miniature tree, depends on the constant activity of these hungry and greedy bunnies. Naturally, gorse, if left to itself, would grow feathery from the soil upward, without any gaunt stretch of naked stem at its base; but the rabbits eat off the growing shoots, just as high

as they can reach, by standing tip-toe on their hind feet, so that the resulting shape is a product, so to speak, of rabbit into gorse-bush."

Tell the children to watch in such a place for the worn tracks, from six to nine inches wide, which are the rabbit-roads made by innumerable little feet. If they follow one of these tracks it will bring the children to Rabbit Town.

The town is underground, and the holes are hidden among the black, irregular stems of the gorse-bushes. If the children are very quiet they may see the inhabitants popping in and out of the bushes or of their holes, nibbling the short grass, or sitting up on their hind legs and stroking their faces with their soft paws. A sudden noise will startle them, their ears will be set back, and they will bolt for the nearest hole. If they are in the open or in long grass the children can see what an admirable signal of warning is the white tail which the older rabbit, who has been almost invisible while quietly feeding, suddenly lifts as he begins to run. A stamp on the ground with the hind foot is another mode of warning. The rabbit is so timid and defenceless that his only safety is in burrowing; but he is not such a good burrower as the mole, and likes to work in loose, sandy soil. His burrow goes straight down at first and then branches in various directions so as to make it more difficult for his enemy, the weasel, to follow him.

The homes
of the
warren.

There are many openings, which are used in common by all the inhabitants of the warren, and there are also holes which are merely shelters in case of sudden alarm. The nursery is a special hole, lined with fur from the mother's own warm coat. When the mother leaves her babies she scrapes a little earth before the opening—the only one in this case—so as to screen it from enemies. If the

children keep tame rabbits, they can observe more closely the quick, nibbling movement of the cleft upper lip, and they can notice the two sharp incisor teeth in the upper jaw (there are two others behind them) and the two in the lower jaw. These sharp cutting or gnawing teeth are characteristic of the rodents.

Let the children notice that the rabbit does not hibernate during the winter, as the dormouse does,

Rabbits in winter. though no doubt it has long naps in its warm, "stuffy" burrow. It will come

out, even in the snow, as country children can see by its footprints. The marks of the two front feet will be side by side, but those of the two hind feet will be rather far apart, and one will be a little behind the other. If the short herbage on which it feeds in the open is covered, it will come into gardens for carrots, cabbages, or Brussels sprouts. If mangelwurzels are laid outside the garden fence for the rabbits the cabbages may be spared, and we have the satisfaction of knowing that the gentle, harmless creatures do not starve.

Help the children to distinguish a hare from a rabbit by its larger size, and tell them that being very much

The hare. swifter-footed it trusts to its speed for safety, and instead of hiding underground, as the more timid rabbit does, makes a nest or "form" in the open.

Another burrowing animal—the mole.—During a winter walk across pastures or tilled fields the children will often see, except perhaps in a very hard frost, a freshly turned hillock, which shows that the mole is not sleeping. Indeed, it is so fiercely hungry a creature that it could hardly lie torpid throughout the winter. The mole is not an animal that can easily be observed in the living state, for it burrows so very rapidly with its spade-like hands that it seems

to disappear into the ground as if by magic. But a dead or stuffed mole may be shown that the children may see its wonderfully-formed front feet or hands, its soft, close fur, which will "set" either way and gathers no soil upon it, the sharp snout, the tiny eyes, and apparent absence of outer ears, although, indeed, the mole's hearing is wonderfully keen. Diagrams of its elaborate burrow are very frequent, but children do not always understand that its central fortress is generally in a hedge or under a tree, and that the "molehills" which they see are not part of the home,

**Compara-
sons with
the rabbit.**

but the earth thrown up in fresh feeding-places where the creature has been digging for the worms or grubs which form his diet.

For, unlike the vegetarian rabbit, he is an exclusively animal-feeder, and hence he likes a tilled or pasture soil, rich in worms and larvæ, better than the loose, sandy, but poor soil which best suits the rabbit. In hard weather, when the worms burrow deeply, he has to pursue them to greater depths, and, as Gilbert White pointed out, his heaving and working at the surface is a sign of a break in the weather. All this turning over and tunnelling of the soil is good for the land, even apart from the consumption of seed-devouring and root-devouring grubs. Country children ought to be strongly influenced against the barbaric custom of killing and impaling moles, who, except on a trim lawn, do more good than harm.

CHAPTER LII

WINTER SCENES : IVY AND MISTLETOE

Ivy.—The ivy has an honoured place among English evergreens ; perhaps because it is so homely, so accommodating, clothing alike either an old ruin, a hedge-row, a dead tree-trunk, or the wall of a suburban garden. It is an interesting plant which the children can observe all the year round, and, unlike most plants, it is more interesting in the winter than in the summer.

The "habit" of ivy.—Let them notice, in the first place, how ivy spreads itself over the ground, or how it trails along a bare bank. The shape of each leaf is quite characteristic, and the children will at once recognise its five deep lobes (sometimes three in the younger leaves) with the sharp angles and points. It has the characteristic evergreen texture, firm and glossy. Let them notice an individual spray, how the leaves give way to one another, exhibiting, as has been happily said, a "leaf courtesy," laying themselves out flat, with the pointed lobes of one leaf fitting into the angles of its neighbour, so as not to crowd or overlap. Let the children draw such a spray, in order that they may better realise this mosaic arrangement. The ivy is a shade-loving plant, and hence it is important that all available light should be utilised in this way.

Leaves on the ground.

Leaf's adjustment for climbing.

Let them now look at ivy climbing over a hedge or up a wall. Here the older leaves are modified a little; the outside sprays do not flatten themselves

closely against the wall, but stand forth, as it were, on longer stalks. The lobes are not quite so deep and the angles are not quite so sharp. We have now the broad-arrow-like shape of leaf seen in other trailing plants, such as the convolvulus and black bryony.

If now we compare the ivy at the top of the hedge, wall, or tree-stump, we see that the leaves are almost like the typical foliage leaves of other plants, oval, and

Leaves at the summit. pointed at the tip. The lobes, with their acute points and the sharp angles, have

~~disappeared~~, and the leaves hang out loosely on long stalks all the way round the stem. The mosaic arrangement is no longer required, for there is plenty of light and air for all, and to reach it they have only to thrust themselves out, as it were, on the long stalks. Even now, though there is no need for so precise a fitting in, they are arranged in a spiral round the stem, so that in thrusting outward they do not get in one another's way.

It is among these upper branches that the flower-branch appears. Each branch carries a group of yellowish-green flowers, whose stalks radiate from one point, so that they stand out in a semi-

Ivy flowers. globular head. These flowers come late in autumn, when other flowers have failed. On a disc in the centre of each blossom there is produced a quantity of honey which provides an autumnal feast for hundreds of flies who

incidentally carry pollen from one flower
Ivy guests: to the pistils of another. "Ivy bloom is
for food.

Nature's last roll-call of the flies: to it muster the battered remnants of great armies of winged folk" (Phil Robinson, "Orchard, Garden, and Spinney"). For these visitors to the ivy the garden spider, chestnut-coloured, with a white cross on her back, has ready near at hand her spiral web, looking at first sight like a series of concentric circles with connecting radii.

The web is a very pretty object when seen with the autumn dew upon it or outlined among the ivy by the first touch of frost.

The blossoms of the ivy, which are very insignificant, fall off, but the berries remain to ripen slowly through the winter into a black fruit which will be eaten by birds. The "berry" of the ivy resembles that of the haw—a pulpy covering with a hard indigestible seed inside.

A tuft of ivy—dense, warm, weather-proof, and dark—forms an excellent refuge for wintering insects. Very many of those who came to banquet at the little circular tables so richly spread with honey have perished with the first frost. But some remain—the queen wasp, who, if she does not venture out too soon into the deceptive winter sunshine, will become in the spring the builder of a marvellous paper dome enclosing many chambers, and the mother of a big brood of wasps—the feeble old bluebottle—a butterfly hatched late in the summer, who folds her wings so as to look like a bit of dead leaf—many a motionless chrysalis—are concealed under that dense mass of greenery. Here, too, the hibernating snails congregate in a bunch, "pretending to be only knobs upon the wall." And here may be heard on winter mornings the restless chattering of sparrows, for they also find the ivy a warm covert.

How does the ivy climb? Not by stem, nor by tendrils, nor by leaf-stalk, for it is unlike the other climbing plants we have noticed throughout the year. Little tufts of brown root-

How ivy climbs.

like fibres are given off along the stem on the shaded side—the side nearest the wall, and opposite to that on which the leaves are ranged. These are what the botanists call "adventitious" roots, because they come forth in regions of the plant different from that in which the typical root appears. These root-like threads do

not absorb nourishment for the plant, as true roots do ; they only cling to the wall or tree-trunk, and give out at their tips a kind of cement which enables them to hold on firmly. Thus the ivy is not a parasite ; it does not feed on the tissues of any tree round which it may

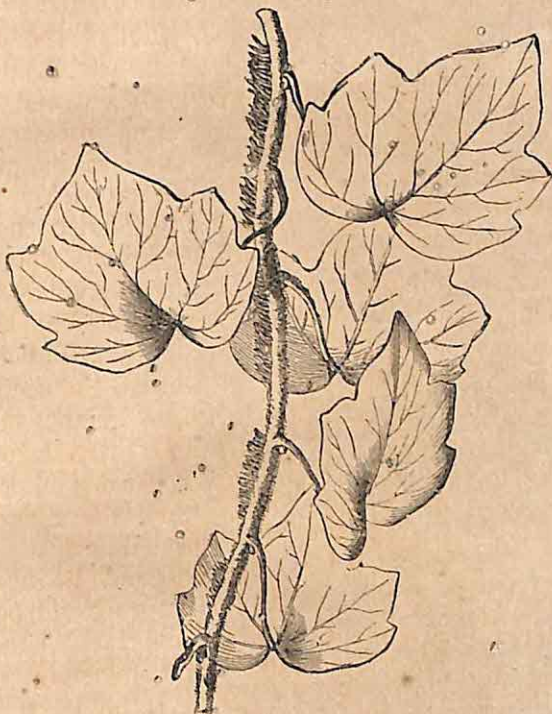


FIG. 67.—IVY, WITH ROOT-LIKE FIBRES FOR CLIMBING

happen to climb. If it does harm to its living support, which sometimes occurs when it is very luxuriant, it does so by excluding light and air.

When a frost comes, let the children notice the fairy-like effects produced on ivy and other evergreen leaves, as also on bare twigs, the edges of blades of grass, &c.

They may notice, especially in the leaves of ivy and holly, that the centre of an evergreen leaf is still comparatively green, while the veins and the margins are picked out, as it were, in filigree work. This is because the cells of the green part of the leaf, protected as they are by the glossy membrane above, are *alive* and at work, and therefore there is still some little warmth in them, just enough to prevent the formation of the ice crystals, while the non-living structures—mere fibres—have no heat of their own, and thus allow the frost to settle.

The author whom we have quoted above, Phil Robinson, points out how the various trees, and especially the evergreens, have, as it were, an individual way of clothing themselves with their snow-garment. "The laerels and ivy are deeply coped with snow—their broad leaves hold it well; but the japonicas are only outlined in white.

Trees in snow. The yews, drooping long feathers of snow to the ground, are beautiful beyond words, and the oak's stiff branches, straight-stretched before it, are spangled to the tips. The leaves of the box and barberry are every one of them fringed with loveliest lace, and the birch, the lady-tree, stands like a bride in her veil. The firs are wonderful—weird and fairy-tale-like—what might not easily happen at Christmas-time in a forest of fir trees! and beautiful above all are the great elms, like frozen fountains. Every tree, every shrub, takes the snow to its own personal adornment as it will, as it may."

It is worth while taking advantage of the day after a snow-storm to tell the country children to notice their favourite trees along the road to school, or to make a little excursion with town children to the nearest park, in order to make them see that a snow-storm may have other significance than snowballing or a snow man. And in speaking of snow we are reminded that while

teachers very often give lessons on snow, under the headings "Causes, Uses," &c., with neat blackboard drawings of the hexagonal crystals, few **Snow crystals.** remember to tell the elder children to beg a piece of old velvet, or even to extend a black-sleeved arm to receive flakes of gently falling snow, when these lovely branched crystals can easily be made out with the naked eye, though a hand-lens is better.

The mistletoe.—Christmas brings the mistletoe, and in every school the children will be drawing, painting, or modelling the pale, scimitar-shaped leaves, coming off in pairs in a forked fashion from the light-green stem, and the clusters of pale translucent berries in the angles. In their history lessons the children learn that the mistletoe grew on oak-trees, from which it was cut down by the "Druids." As a matter of fact, it rarely grows on oak, and it must have been the rarity of the conjunction of the **Its folklore.** two plants, that impressed these ancient folk.

The elder children may be led to realise how mysterious these very bright tufts of living green must have appeared among the gaunt bare boughs. The mistletoe cluster seen aloft was a gleam of life and hope in the midst of the desolation of winter, and therefore sacred. Professor Arthur Thomson, in his "Natural History of the Year," has an interesting chapter on the mistletoe and its connection with bygone beliefs and worship—a connection which excludes it from the decoration of churches, by-the-bye, though this is not easy to understand in view of the policy which led Pope Gregory and his agents to appropriate rather than to destroy or ignore the sacred oaks, sacred wells, and other natural objects dear to the simple pagans who lived near them.

Modern school children know that the mistletoe is a parasite, living chiefly upon the apple and the poplar, though it will thrive on other trees. It is not a parasite

of the worst type, for though it does push downward its sucker-like roots into the branches of its host, and draw out the nutritious sap, it, nevertheless, manufactures some of its food from the air with its own green leaves.

Its life history.

The children will want to know how it came on the apple-tree, and the teacher can tell them the story of the missel-thrush, or storm-cock. He is called the storm-cock because he will sing defiantly and loudly on a tree-top even while a storm is blustering around. He is a relation of the song-thrush, who haunts the lawns and digs out worms from their burrows, or breaks the shells of hapless snails on a favourite stone.

Its connection with the missel-thrush.

The missel-thrush is larger than his cousin, more spotted, and with more white showing under the wings as he flies. He is more vegetarian, as a rule, in his tastes, and pre-

Comparison with song-thrush.

fers a diet of berries—hips, haws, and other wild berries form his winter fare—but he is specially fond of the mistle-toe berries, hence his name. The mistletoe plant, for its part, seems to depend on this particular thrush to disperse its berries. They are so sticky that the seed is easily glued to the thrush's beak or feet, or they are dropped by him after a meal provided by the gummy outside portion. The fork of an apple or poplar tree is his favourite perch, and the sticky seed, resting in this fork, germinates on the spot, and sends down the suckers which penetrate into the tissues of the host. These finally produce the great tufts or stems about three feet long, looking like small aerial bushes, which, unnoticed amid the foliage of summer, stand out conspicuously enough in winter. This connection between bird and plant is one of the most striking instances of the many interconnections in the "web of life" which may be brought under the children's notice before the year closes.

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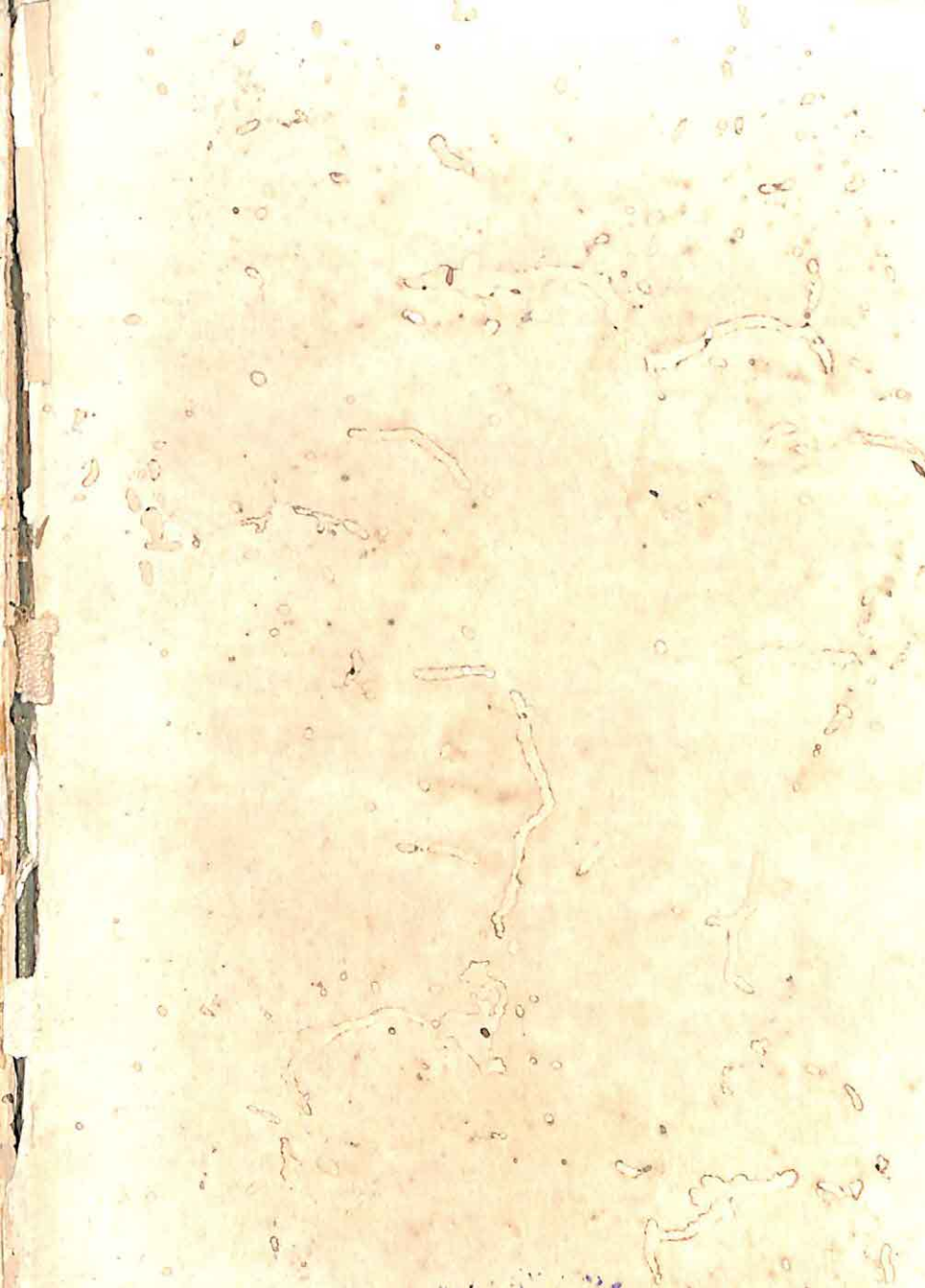
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